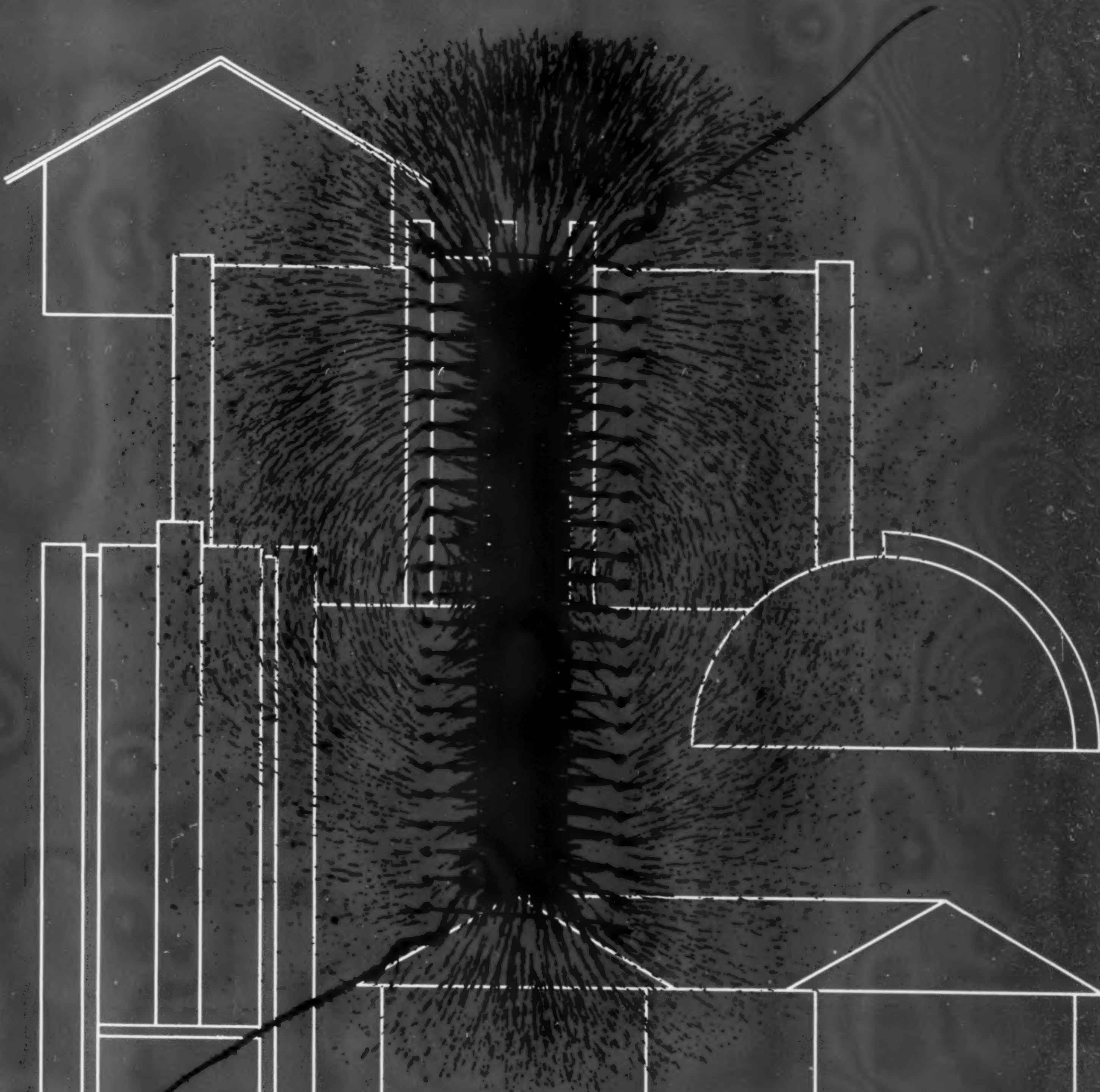
THE SCIENCE TEACHER

VOLUME 27, NUMBER 1 • FEBRUARY 1960



SCIENCE FACILITIES ISSUE

THE SCIENCE TEACHER

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association

Volume 27, Number 1 • February 1960

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Beginning with the first 1960 issue of *TST*, your professional journal makes its debut in a more functional format. The 1960 look *(le moderne)* has been designed and planned in the interest of upward communication and effectiveness. Upward communication is the road to higher standards and outstanding competence in content, design, readability, and display.

The new type face you are reading is Times Roman. New heads have been introduced to increase the effectiveness of design, as well as to produce a saving in space utilization. This is accomplished through the use of both two-column and three-column format. With the change to a larger size of 8½ by 11 inches, text content for each page is increased by more than twenty per cent. In addition, there is more allowance for unlimited flexibility and arrangement of copy, illustrations, and advertising insertions.

Although the readers may not be aware of it, the use of the standard three-column width, with the clear, sharp face type, will reduce the factor of fatigue in reading. The shorter column length with fewer words will also be a time-saver for the reader. Studies in recent readership surveys on these matters have convinced us that the reader must be given important consideration in effecting any changes in a publication.

We are pleased that so many of our advertisers have expressed their pleasure in the conversion of *TST* to a more standard-sized format. We know that many companies use the same insertions for several publications, and this permits the use of the same insertions or plates without additional costs. In addition, we are able now to accept advertising from other companies who have not been able in the past to comply with our specifications under the smaller format. The use of space units in varying sizes allows those advertisers with limited funds to schedule insertions within their established operating budgets.

Confidentially, there are three thousand more words that could be listed under the advantages of our new journal. No illusive planning produced these results. At the Magazine Advisory Board meeting in Atlantic City last year, your Associate Editor submitted a proposal to consider a new format. After a study of this proposal, the MAB members voted unanimously for the change.

We hope you will agree with us that it represents the forward look, and not satisfied to stop here, the Magazine Advisory Board is planning on content improvement for future issues.

Frances J. Laner

Associate Editor

THE SCIENCE TEACHER

The Journal of the National Science Teachers Association, published by the Association monthly except January, June, July, and August. Editorial and executive offices, 1201 Sixteenth Street, N.W., Washington 6, D. C. Of the membership dues (see listing below) $3 is for the Journal subscription. Single copies, $1.00. Second-class postage paid at Washington, D. C. Printing and typography by Judd & Detweiler, Inc., Washington, D. C.

Articles published in *The Science Teacher* are the expressions of the writers. They do not, however, necessarily represent the policy of the Association or the Magazine Advisory Board.

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The membership year extends for one year from date of enrollment. Subscriptions are entered for either the calendar year or the school year.

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* Includes the *Elementary School Science Bulletin* published monthly from September through April of each year.

Preparation of Manuscripts for Publication in *The Science Teacher*

General Rules

The manuscript should be informative, summarizing the basic facts and conclusions, and maintaining a coherence and unity of thought. Basically, be clear, be concise, be complete, and place yourself in the mind of the reader. The titles should be clear and accurate, but need not be lengthy. Rules for grammar and punctuation follow the usages summarized in the latest edition of *Webster's New Collegiate Dictionary*.

1. Preview

Manuscripts sent to the editorial office for review are accepted on a voluntary basis from authors. Before an article is submitted, please review the following suggestions. Original manuscripts received in correct form serve to expedite the processing and prompt reviewing for early publication. Spelling, punctuation, sentence structure, and the mechanical elements of arrangement, spacing, length, and consistency of usage in form and descriptions should be given careful study before submission.

2. Prepublication

No manuscript is accepted which has already been published or has been submitted to another journal for publication. Authors should include statement of nonpublication or submission with their letters of enclosure.

3. Acknowledgements

All manuscripts are acknowledged upon receipt without obligation for publication. Review of a manuscript may require from two to four months before a final decision is made for publication or rejection. When an article is selected for publication, the author is notified, and alterations may be made at that time. No galley proofs are sent to the authors before publication, and final editing is made by the publisher.

4. Manuscripts

a. Format—Submit original manuscripts in English, typewritten, double-spaced on one side of the paper, and in duplicate.

b. Length—In general, articles should not exceed 2000 to 2500 words.

c. Page size—Original should be on 8½- by 11-inch bond paper, with margins of 1½ inches on each side and at the bottom.

d. Title sheet—Include a title sheet to precede the first page of the article. Give the title of the article, name of author(s), present position or title, and name and location of school or college (city and state).

e. Pages—Number each page (except the title page) in Arabic numerals at the bottom of each page.

f. Bibliographies or references should be carefully selected and kept to a reasonable number of citations.

5. Footnotes

Number footnotes to *text* in single sequence with superior *figures* in order of appearance, and list at bottom of each sheet on which reference appears. (See examples.) For footnotes to *tables*, use superior *letters* (a, b, c, etc.).

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[1] John A. Smith. "The First Law of Motion." *The Science Teacher*, 26:33-6. February 1960.

[2] Sam A. Jones. *Hydrodynamics*. Oxford Book Company, Chicago, Illinois. 1960. p. 573-6.

[3] Samuel Schenberg. *Laboratory Experiments with Radioisotopes*. United States Atomic Energy Commission, Washington 25, D. C. August 1953.

6. Tables

All tables or tabular material should be prepared on a separate sheet at the end of the running text. Number in Roman numerals, and type captions at the top of each table. Avoid complicated column headings.

7. Figures

Line drawings should be planned for reduction to the $2\frac{5}{16}$-inch column width (14 picas). Lettering and symbols should be large enough so that they will be at least $\frac{1}{16}$-inch high after reduction. Lines should be broad and black. Use India ink and white paper for original drawings. Label all drawings with the word "Figure" and use Arabic numerals in consecutive sequence. Include captions on separate sheets, and also write figure and caption on back of each drawing.

8. Photographs

Submit photographs, if possible—glossy prints preferred, 8½ x 11 inches. Mark only with *grease pencil* on reverse to identify; captions should be typed on separate sheets.

9. Mathematics

Type or carefully print all such material. Separate lines should be used for each equation. If reference is needed in text, refer to as: Equation 1, etc. Use the solidus (/) for simple fractions to save vertical space.

10. Reprints

Reprints of articles are available after publication date. Orders for less than one hundred reprints are not accepted. Cost sheets and order forms will be sent to the authors, as well as three copies of the publication. Original photographs or line drawings may be returned to the author upon request. Artwork or cuts used in the publication are available at no cost to the author.

11. Check list for authors

- ( ) Title page with byline, position, and correct address.
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- ( ) Manuscript, typed and double-spaced, in duplicate.
- ( ) Length not to exceed 2500 words.
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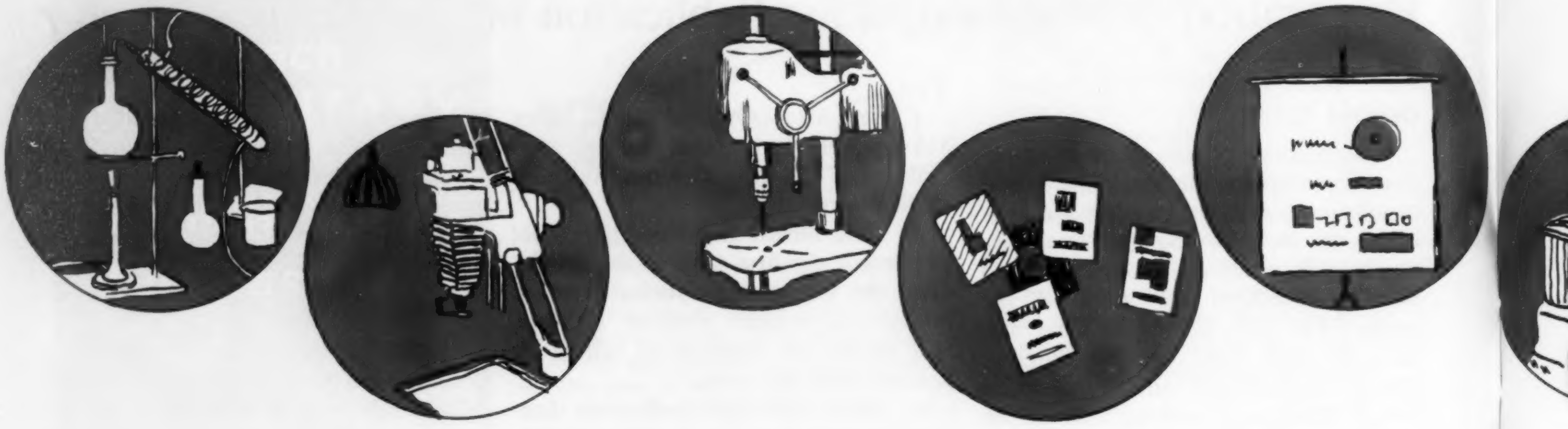


A Center for Science and M

This article and the four that follow present descriptions of current new facilities specially designed for use in teacher education at the college level and in the teaching of science at elementary and secondary levels. Report of a recent survey of high school facilities in several states by the U. S. Office of Education also is included. These articles were planned to describe current building trends and uses to our readers, and to make this information available as teachers, administrators, and school architects plan changes in facilities essential to the emerging science curricula.

By JOHN S. RICHARDSON and FRED R. SCHLESSINGER
Professor of Education — Associate Professor
The Ohio State University, Columbus, Ohio

THE college or university facilities for the preparation of teachers of science and mathematics and for use in their graduate work encompass all of the resources used in their academic and professional education. Few institutions have entirely adequate facilities of either type. While the science facilities may have their limitations, those for science education are often nonexistent or suffer from lack of space and support. Unique facilities are needed to provide those professional experiences which contribute in vital ways to effective teaching. The professional laboratory—a center for science and mathematics education—can house such facilities for the needed activities.

The function of the professional laboratory for science and mathematics teachers follows from the well-known principle that we learn through personal, purposeful involvement in the learning situation. Learning to teach science requires involvement in the activities and situations typical of effective science teaching. The professional laboratory for science teachers must be so designed and equipped that such experiences can be provided. A center for science and mathematics teachers, then, embraces the provisions for a major portion of the activities and the resources essential to those activities.

The activities typical of effective science teaching include discussions, the preparation and presentation of demonstrations, the carrying through of laboratory operations, many of which require unique competence, the preparation of teaching devices, and the improvising and repair of apparatus. Effective science teaching requires the design and use of displays and other audio-visual devices, and the resources needed for the preparation of teaching plans and evaluation instruments. There must be also an opportunity to study the available professional literature including the textbooks, reference books, supplementary reading materials, and the professional journals. The science teacher should become familiar with such resource materials as pamphlets and charts, and other teaching devices that are available or can be made in the professional laboratory. The prospective science teacher must have an opportunity to work with photographic materials; he needs to learn something of paper chromatography, and to experiment with the nurture of living materials.

Courses and informal opportunities for both undergraduate and graduate students can provide for such experiences. A course in the teaching of general and physical science is concerned with such typical areas as the historical and social setting of science teaching, curriculum, procedures and methods,

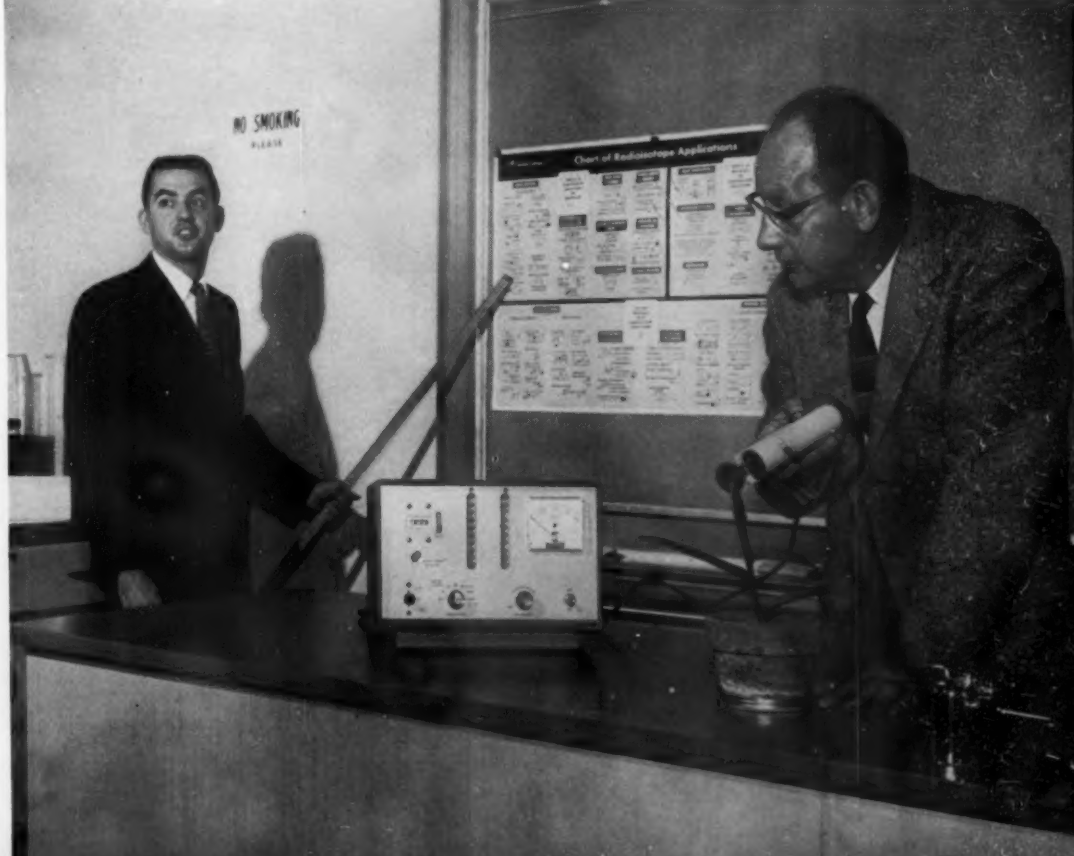
d Mathematics Education

evaluation procedures and materials, and the development of teaching plans. Many facilities are needed to illustrate and develop such facets of the course. A laboratory practicum provides for all students with major areas in science to integrate professional insights and laboratory competence. In this course the essential resources include materials and tools in broad array, as well as representative apparatus for science teaching. Student teaching requires rich resources as unit plans take form, demonstrations are prepared, illustrative material is found, and evaluation instruments are devised. Graduate students find through their course work, such as that in the supervision of science teaching and in curriculum, that the problems they bring from their teaching experience can be handled with greater effectiveness and efficiency through the use of a broad reserve of resources. Research in science education depends likewise upon many materials, particularly those that are made possible by an up-to-date library and reference system.

The present facility in the Center for Science and Mathematics Teachers at The Ohio State University is a classroom-laboratory. This room is flexible in design. Its work tables with formica tops provide not only for general classroom purposes but also for many laboratory activities. A laboratory table along one wall and a demonstration desk at the front provide utilities and added work space. Considerable storage space is available in cabinets; these units can be readily moved to adjust the dimensions of the work areas. The laboratory is equipped as well with a generous amount of chalkboard provided in part by reversible panels of chalkboard and tackboard. Additional panels of steel chalkboard provide for the use of magnetized symbols and other devices useful to science teaching. Because of the conviction that a laboratory should be attractive, the design includes the use of considerable color in the laboratory table tops, the tackboards, and the displays. Within this room are held the teaching operations that range from individual and small group work, to ordinary class

Science teachers work with modern demonstration and laboratory equipment such as the Geiger-Mueller counter and scaler.

PHOTOS BY DEPARTMENT OF PHOTOGRAPHY, THE OHIO STATE UNIVERSITY



In-service and prospective teachers learn to use many types of modern projection equipment. Garland Bookout (left) and Betty Carville.

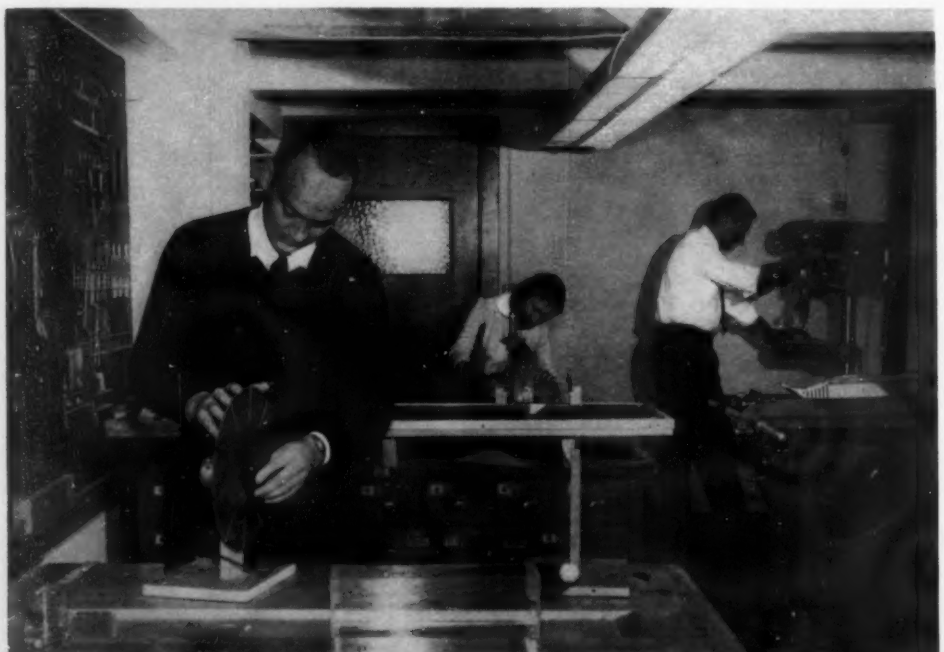
discussions, and to more formal presentations. It serves also as a laboratory for a variety of activities ranging from light craft work, to the explorations of teaching apparatus, and to the building of demonstration devices.

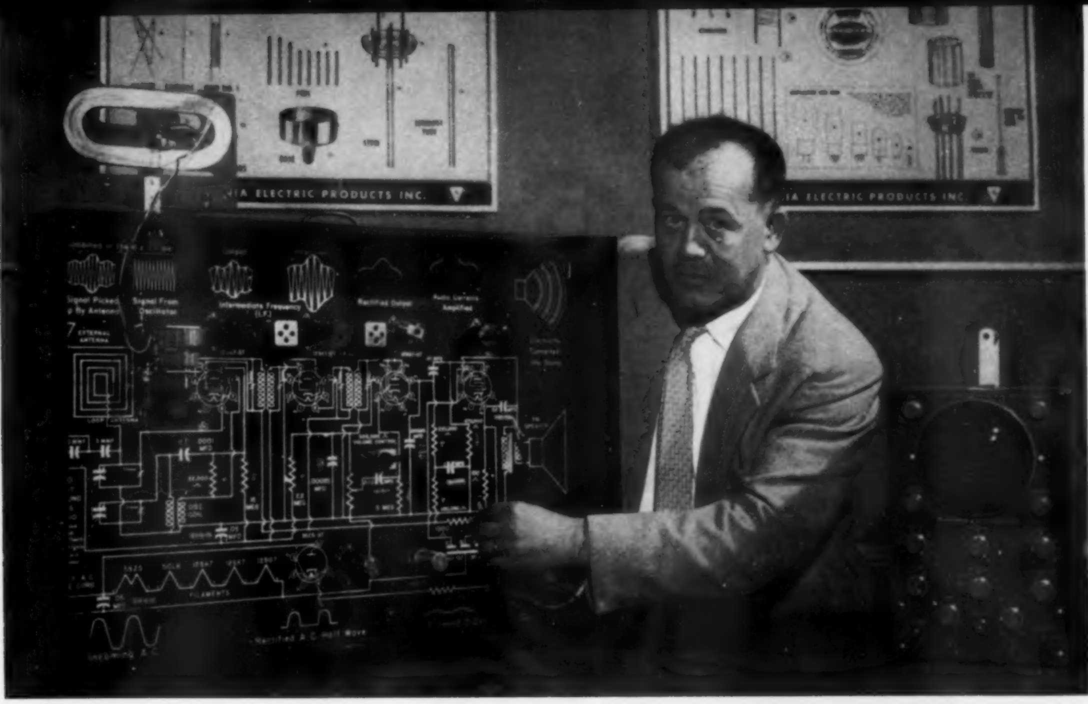
Adjacent to the central laboratory are several auxiliary rooms. A combined darkroom and small chemistry laboratory provide also for work in optics. Another room is equipped with both hand and power tools; in it are stored such accessory materials as resistors, candles, and microscope slides, as well as plywood, plastic, wire, screws, and other materials useful in construction. In an adjacent reading room periodicals and pamphlets are on display. A short stair leads to the space where charts are stored and studied; there is provision also for the design and production of charts with the essential construction materials available. A generous array of industrially sponsored pamphlets is available as is a selection of kits for various projects.

Within the audio-visual room are stored the projection and recording devices as well as film strips and other materials to be used in projection. Adjacent is a storage room for apparatus and supplies useful in mathematics teaching. A seminar room provides for discussion and study groups, as well as for committee work and small classes. The seminar room is equipped with reversible chalkboard-tackboard and with storage facilities. A separate library houses textbooks, reference books, as well as certain other resource materials useful in the programs of science and mathematics education. The staff members in the areas of science and mathematics education and the secretarial staff for the Center are housed in an adjacent suite.

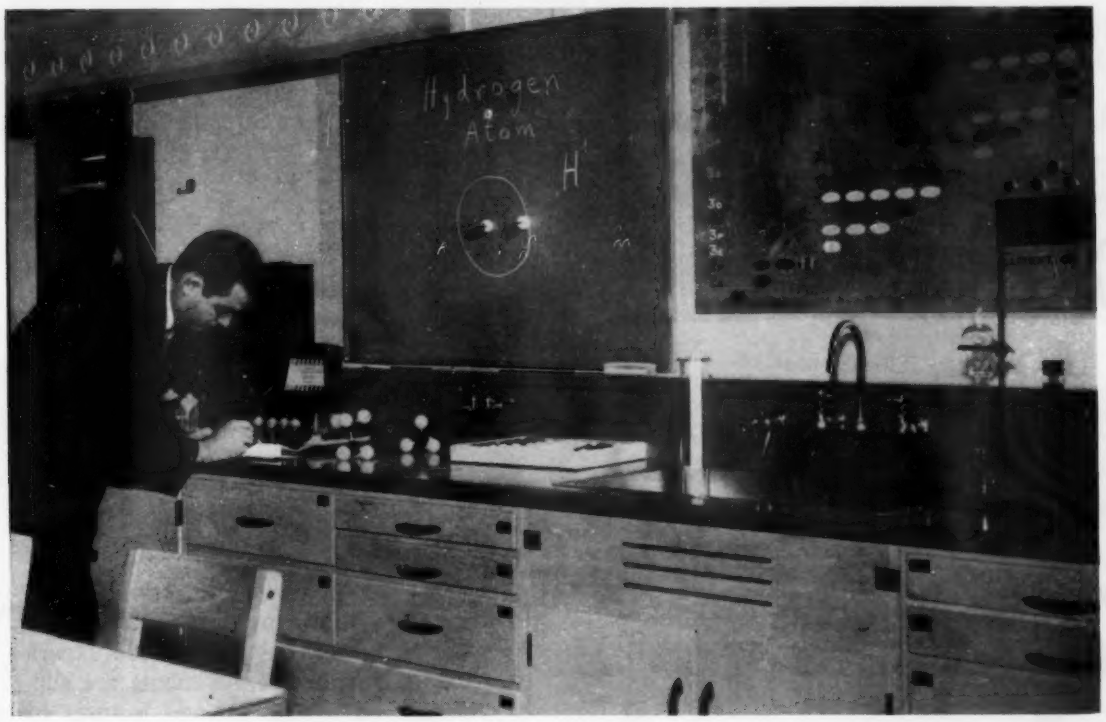
The concept of the Center for Science and Mathematics Education is unifying in more than one sense. It provides a home for those who are developing their professional interests, as well as for those who are satisfying them. It serves as a meeting place for students at various levels of experience to exchange views with others and staff. It brings to the attention of the science teacher the array of resources that he has at his command as well as to provide for him opportunities to use such resources. In a physical sense the Center provides for a greater efficiency of operation than is possible where resources are separated and deployed at various points on a campus. Probably its most important function is to help science and mathematics teachers learn that the solutions to their professional problems, as with the problems of science, can be found in their own laboratory investigations.

Prospective science teachers learn to use a variety of power and hand tools in developing projects and in constructing demonstration and laboratory apparatus. Left to right: Robert Wellman, Betty Carville, and Robert Harmon.



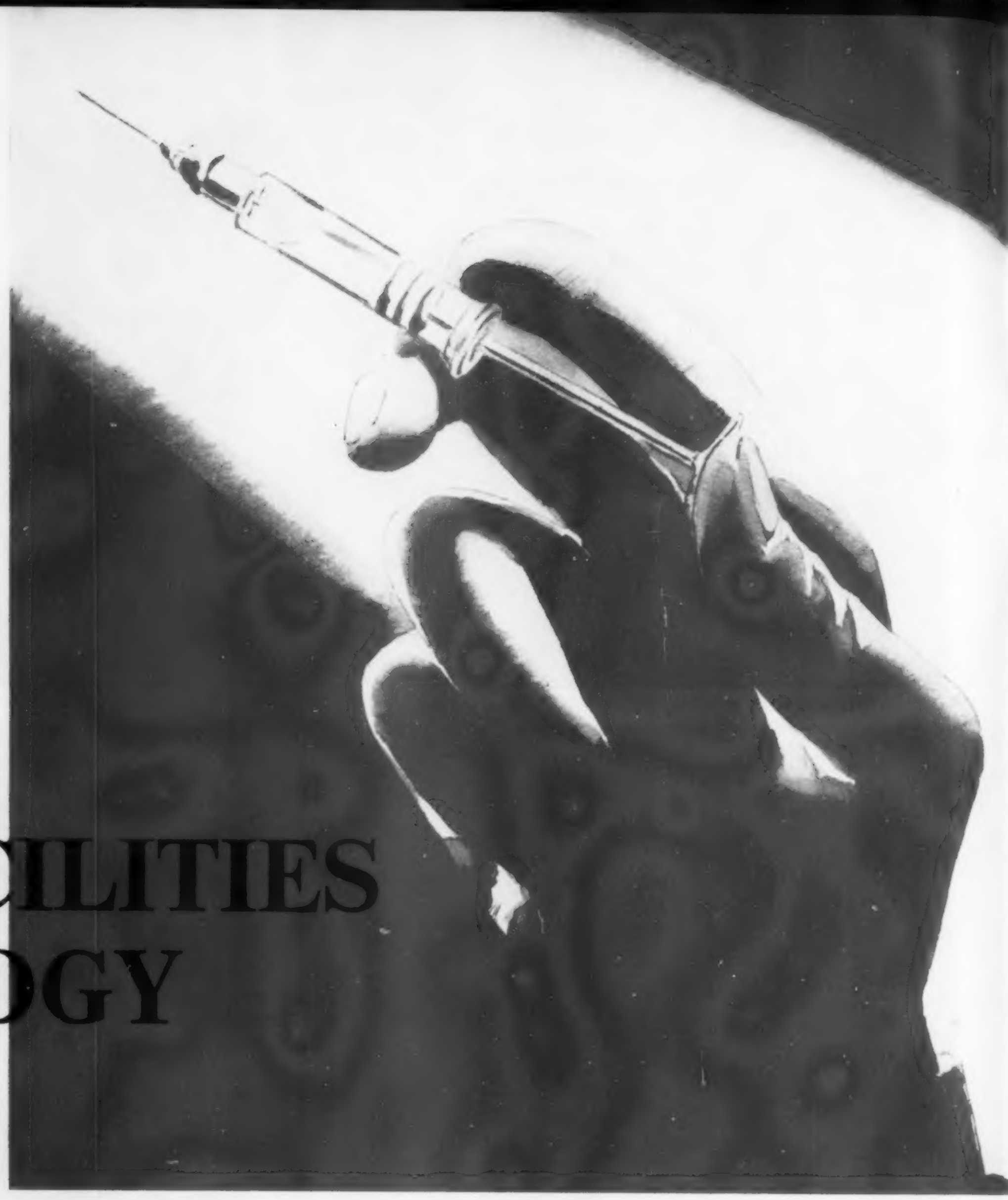


An in-service teacher increases his competence in using the lecture-demonstration method of teaching science.



Science teachers learn to use the materials and equipment of a modern science laboratory.

Many of the commercial science kits and charts are available, as are materials for making charts and other visual aids.



NEW FACILITIES IN BIOLOGY

By FREDERICK R. AVIS

Chairman of Science Department and Director of Precollegiate Science Summer Program of Worcester Foundation For Experimental Biology, Saint Mark's School, Southborough, Massachusetts

THE Biological Laboratories at Saint Mark's School are used for five different courses plus a research program in collaboration with the National Cancer Institute. A brief description of the courses follows.

Program Studies

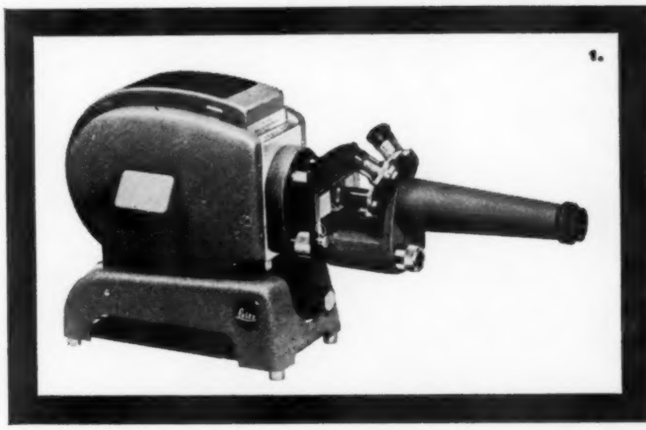
1. *General Science*—It is our practice to take the freshman class and divide it into three equal groups. These groups rotate, spending an equal amount of time in earth science, physical science, and biology. In the latter course, in addition to microscopic study of the cell, the students dissect the mouse. They are given lectures on the anatomy of the human and, after observing the differences between their mouse and the human, write a report on their findings.

2. *An Introductory Course in General Biology*—This is an elective course for sophomores and seniors. The class work follows the format of a good college introductory course. The laboratory work, however, emphasizes work with living animals and some of the physiological and biochemical aspects of the life sciences.

3. *Advanced Biology*—This course has two prerequisites: general biology and chemistry. It emphasizes problems in biochemistry and physiology to a greater extent than given in the introductory course.

4. *The Scientific Society* — Friday evenings during the regular school year students take part in further experiments and these experiments are supplemented by movies and lectures by scientists from the surrounding area, Worcester and Boston. These meetings are for an hour and a half and have proven to be a great success.

5. *The Precollegiate Science Summer Program of the Worcester Foundation for Experimental Biology* — Each summer the Worcester Foundation, in collaboration with Saint Mark's, conducts a program for talented boys and girls who are definitely motivated toward the field of the biological sciences. Approximately thirty students are selected from all parts of the country. They are housed in the dormitories of Saint Mark's and use the athletic and library facilities. The first-year students use the biological, chemistry, and phys-



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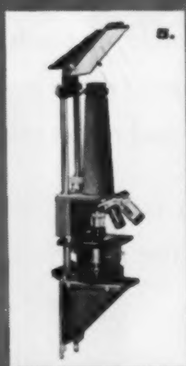

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A number of Summer and In-Service Institutes will be given at several colleges and universities for the school year 1960–61. Through these institutes teachers who are already teaching the PSSC course and those who are planning to offer the course in the near future will have an opportunity to exchange ideas and share enthusiasm with high school teachers and university physicists who have had extensive experience with the course. Although it is possible to teach the PSSC course without participating in the Summer or In-Service Institutes, these programs provide a valuable introduction to the course, its methods and goals, and direct experience with its laboratory activities.

If you have not already received notice of the Institutes and would like to know more about the programs, write to:

EDUCATIONAL SERVICES INCORPORATED
164 Main Street
Watertown, Massachusetts

FIGURE 1. Foreground shows old laboratory with limited work space. New wing detail in background.

ics laboratories at Saint Mark's. The purposes of this program are to bring the student into close contact with professional scientists, to instruct them in the techniques used in advanced work, and to give them some research experience. Each year a few students are selected to return for a second year. These boys and girls go to the Foundation daily for work on a specific research problem under the sponsorship of one of the professional research men.

6. *Cancer Research in Collaboration with National Cancer Institute*—This program is carried out by the author with the help of a research assistant and a part-time technician. It is concerned with the study of the effects of anti-cancer substances on the perfused bovine blood, liver, and kidney. This research program was inaugurated in the spring of 1958. From the purely scientific aspect, the program is proceeding smoothly and with considerable success. Educationally, it is proving a very significant factor in stimulating secondary school students to select careers in science. To have specific research carried out on studies of interest to the students while taking their courses creates a definite motivating factor.

Science Laboratories

In 1950, Saint Mark's built a science wing which consisted of laboratories for physics, chemistry, and biology. Due to the increased amount of activity in the biology department, however, it soon became evident that an addition was necessary. This was undertaken last spring at a cost of $50,000. Figure 1 shows the old laboratory in the foreground and the new addition in the background. The new wing has a basement which consists of a chemical storage room, a storage room for glassware, instruments, etc., an office for the research assistant, and a well-equipped photographic darkroom. The darkroom is used by the students throughout the year for taking photomicrographs of tissues which they prepare by histological sectioning. It is used also by the photographic section of the scientific society and the group working on the cancer research program.

Figure 1 above shows the relationship of the old laboratory to the new. In the room a group of students in the Summer Program are recording by means of kymographs the effects of various drugs on the heart action of the turtle. Use of both laboratories permits the progress of several projects at the same time.

Figure 2 represents a picture of the new laboratory from the connecting door. The student benches and those along the walls have stone tops. The young man on the right is working with a Warburg apparatus. Students in advanced biology and in the Summer Program use this apparatus for measuring the oxygen uptake of various normal tissues and cancerous tissue before and after the addition of an anti-cancer

drug, 6-mercaptopurine. Directly behind the young lady in the foreground is the operating area which is used for research that the author has begun relative to the transplantation of organs from one animal to another. Our work is concerned with the transplantation of ovaries in the rabbit. Because this work involves the transplantation of tissues which must be free of any bacterial contamination, complete aseptic surgery is used. Students in advanced biology, scientific society, and the Summer Program are carefully trained as teams to assist the author. They learn to administer anaesthesia properly, and scrub and put on sterile gowns and gloves following the same procedure used in hospital operating rooms. This affords students a firsthand opportunity to discover whether or not they have aptitude for this branch of medicine. The two people in the background are conducting a dual perfusion involving a liver and kidney. Another term often used in reference to the perfusion apparatus is simply mechanical heart and lung.

In the far left-hand corner of the picture the reader will note a water still on the wall. The apparatus is suspended over our solution bench which consists of a sink and an RX Torsion balance which is used for making many of the regular solutions. In the far corner of this bench is a Mettler B6 Precision balance. This is for making the more exacting formulas such as those involving hormones and vitamins. On the back wall is a cabinet which houses the most commonly used chemicals. Directly beneath this cabinet is a small blackboard for calculating dilutions, and needed information.

Figure 3 is a view of the new laboratory looking toward the old room. In the right-hand and left-hand corners are the fume hoods which are used for biochemical extractions. One example requiring the use of the hoods is concerned with the synthesis of ergosterol by the mold, *Neurospora crassa.* The ergosterol is extracted from the mold and the amount present is determined by means of a Coleman spectrophotometer which is shown on the bench alongside of the fume hood on the left.

Next to the spectrophotometer is a microtome and slide warmer. On the opposite side of the room next to the other fume hood is an autotechnicon and a paraffin imbedding oven. This is our histological unit used by students to prepare tissues. Beyond the paraffin imbedding oven is a clinical centrifuge which the students use for studies of blood and urine. Following this is a balance for weighing animals and organs; then a hematocrit centrifuge with the micro-capillary reader which makes it possible to determine the corpuscular volume of blood samples. On the student desk in the foreground is a dissecting microscope with a zoom lens.

FIGURE 2. New wing of laboratory is entered through connecting door of old facilities. Lighting, space arrangements, and suitable equipment enhance student progress.

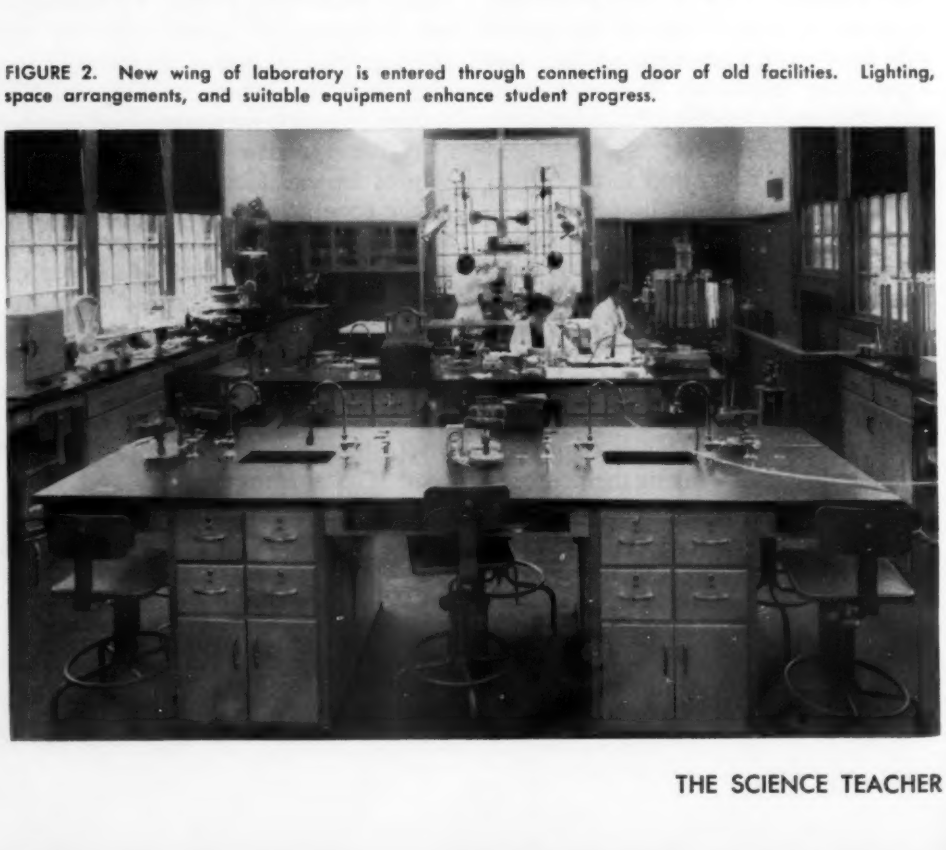
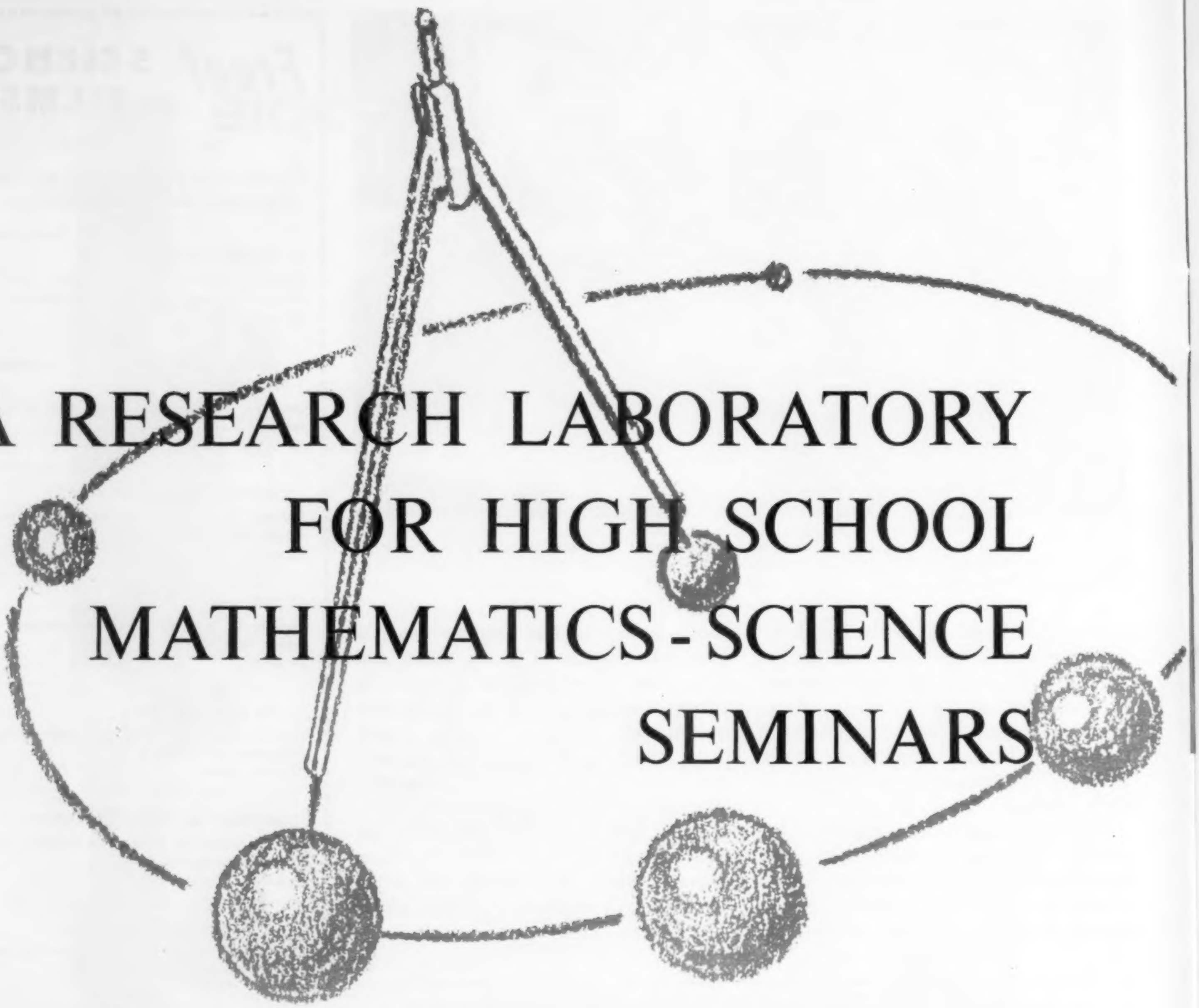


FIGURE 3. Laboratory unit includes various types of apparatus and equipment as fume hoods in left and right background, Coleman spectrophotometer, microtome, and others as described in text. Note ceiling exhaust fan.

On the right-hand side of the bench behind this is a Roller-Smith balance for weighing of tissues and small amounts of chemicals. In the ceiling is a large Davidson exhaust fan which removes fumes from the laboratory and helps to make both laboratories comfortable in the summer.

At Saint Mark's, we realize how extremely fortunate we are to have such excellent facilities for teaching and research. In conclusion it should be mentioned that this has not occurred by sheer luck. It has required nearly twenty-five years of much effort and experience to achieve the program in effect. It is the hope of the author that this article will inspire young people in the teaching of science at our secondary school level to work diligently, take fruitful courses regardless of credit, in order that they may also enjoy the same opportunities. Today it has been demonstrated that students can learn and be highly motivated in such scientific surroundings.



A RESEARCH LABORATORY FOR HIGH SCHOOL MATHEMATICS-SCIENCE SEMINARS

By MURL B. SAILSBURY

Science Teacher, Mathematics-Science Seminars, Evanston Township High School, Evanston, Illinois

MATHEMATICS-SCIENCE Seminars at Evanston Township High School have been in progress since 1950. As the program expanded, it became increasingly clear that a multipurpose laboratory was needed to continue interest and to obtain maximum results in advanced science projects. Plans for a typical laboratory for research level studies and projects were carefully developed by the author over a period of ten years.

Discarding the stress on structural plans and details, the author directed emphasis in design and use to obtain greater flexibility and efficiency in the conduct of science projects. The creative process in design, however, was not overlooked, and the facilities represent an unparalleled integration of education and architectural philosophy.

With the avid interest of Mr. Thomas Wilson, who shared the working facilities with the author, and the cooperation of the school administrator, the laboratory as visualized became a reality in the summer of 1959. The author predicts that maximum results in the use of the facilities will require a minimum of two years. Seminar work projects begun in the limited work space can now go forward without this handicap. Readers interested in visiting the laboratory facilities, or obtaining information on the progress of the program are invited to write the author.

The facilities of the laboratory follow closely the philosophy of seminars in which students do their own teaching of advanced mathematics-science areas and in which each student does a research level study or project.[1] Teaching areas include number systems and theory, symbolic logic, set theory, ion exchange, atomic physics, space rockets, satellites, computers, and theory. All seminar work is carried on with a maximum of student responsibility for self-directed work and professional behavior. Library materials have been made available which contain technical

[1] Murl B. Sailsbury. "Mathematics-Science Seminars." *The Science Teacher*, 26:150. April 1959.

references for these studies and projects.[2]

Provisions have been made in the laboratory to enable students to pursue any advanced level study or project idea regardless of other courses, subject matter, career, or traditional laboratory boundaries. The new facilities occupy space which formerly housed a regular biology laboratory and recitation room separated by a large-sized office. These quarters had been used extensively for seminar project work, but with limited space and facilities. Even though biology periods were in session, project work was done at the same time by seminar students, and during any period in the day, as well as before and after school. This principle of operation will be retained in the design of the new laboratory as it enables one faculty member to supervise effortlessly a number of students working at the same time. It has been established practice for many years. Occasionally, project work had been done in the chemistry and physics laboratories, but most of it was done at home. Because of the diversity and quality of the work and the number of students engaged in it, the new facilities were designed for greater flexibility in each project.

The new laboratory has fourteen double student desks for biology. Each desk has fourteen drawers with locks. Special research tables (counters) line the periphery of the laboratory. These contain the provisions for the seminar work. Each work area has its own cup sink, 117V-AC electricity, gas, raw water, piped de-ionized water under pressure from a central unit, and permanent air pressure outlet and vacuum inlet. All counters have one row of drawers with locks and flush plates for tapered rods, two feet apart. Few spaces beneath the counters are built in because it was impossible to predetermine the desirable locations for storage spaces. Counters with drawers are a standard height off the floor so that standard units of shelves, drawers, and the like may be added as needed.

Movable "greenhouses," heated with electric blankets, are in front of the two central laboratory windows. Water and electricity outlets are available on the ends of the adjacent research counters.

One L-shaped research counter is intended primarily for electricity and electronics work. Adequate electric circuits are provided. All circuits are on a remote relay switch with button switches on each counter of the "L." All outlets in the laboratory are 117V-AC, standard house current, and are grounded. Thus, two safety measures are present. Portable power packs (AC and DC) provide additional voltages ranging from any fraction of a volt to thousands of volts.

Additional electricity and electronics equipment includes oscilloscopes, signal generators (audio and video), test equipment, amplifiers, tube-transistor testers, meters, and tools.

Another counter section on the periphery of the laboratory contains a built-in refrigerator, a live animal section, and enclosed shelves and drawers for storage purposes.

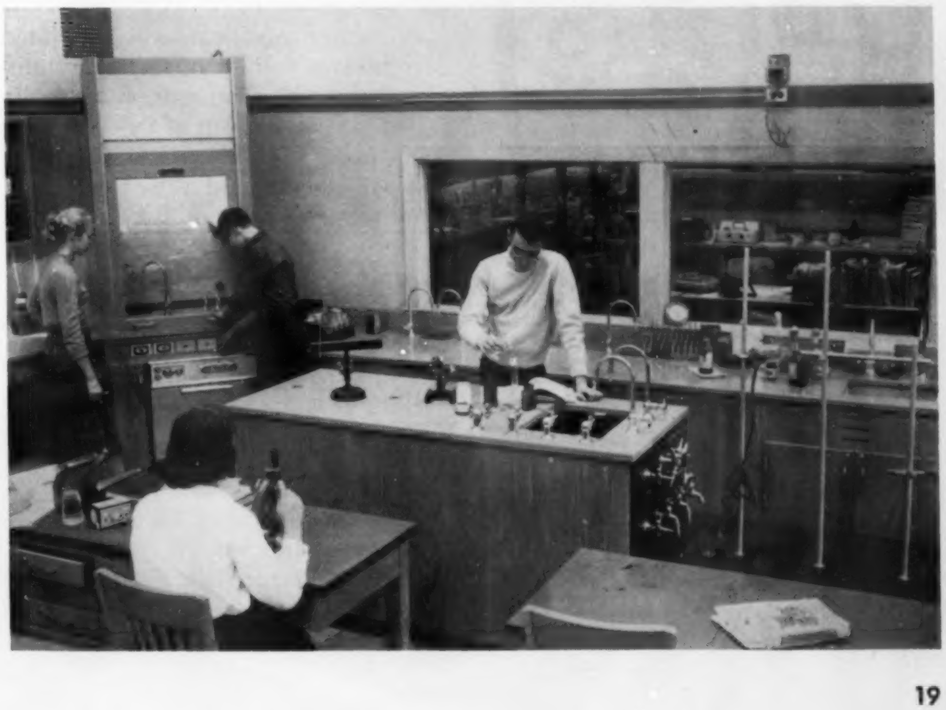
All facilities are available on the general purpose counter along the long wall oposite the window wall. The air compressor and vacuum pump are located beneath this counter. The entire length of the section is equipped with twelve-inch deep, wall-hung display storage cases placed above the counter and clearing the water spigots by several inches. Fluorescent lighting is recessed beneath each case to provide illumination for the work areas. These lights may be controlled individually or as a group from the central panel in the office area.

A large plate-glass window, based thirty-six inches off the floor, was installed in the wall between the office and the laboratory. This is the front of the laboratory. Beneath this window on the laboratory side is a case for permanent storage of thirty-five or more microscopes. Standing thirty inches off the floor, it contains all facilities and cup sinks as well as a large general purpose sink; it serves as a research- or teacher-work area.

Although of standard size and design, the demonstration desk has been drastically modified. All facilities are on the top. Provision is made for full-scale, industrial, hand-operated glassworking equipment. Oxygen tanks and a high volume air blower are built into the table. Controls are located at the front. Portable sheets of transite fireproof the table top. When it is not used for glassworking, the desk appears to be a regular demonstration table with a few gimmicks. Transformation takes only a minute.

An industrial distillation stand with its own sink is located to the left of the demonstration stand and attached to it. Four flush plates for tapered rods are spaced down the center of the stone surface and permit simultaneous setups. All facilities for the distillation stand are built into the adjoining end of the demonstration table. This table area has four electric circuits.

Demonstration table and distillation center in foreground. Microscope storage case and research counter are beneath window viewed from office quarters in next room. Note outlets for TV on upper wall center.



[2] American Library Association. *Top of the News*. May 1959.

A fume hood is located at a forty-five degree angle in the corner to the left of the microscope case. The hood joins to the counter and display cases on the other wall and contains all facilities, many operated remotely. Several modifications were made on the fume hood and base. It has long been believed that the primary corrosion culprits in a laboratory were ammonium hydroxide, hydrochloric, nitric, and acetic acids. Since this laboratory accommodates equipment from any of the sciences, corrosion could become a major problem. Special storage shelves were built into the hood to house all containers of the corrosive chemicals. They are stored in no other location and stocks are kept at a minimum. One or more students search for a corrosive atmosphere by using small sanded iron strips as indicators. If necessary, corrosive chemicals will be further isolated by storage in tied polyethylene bags.

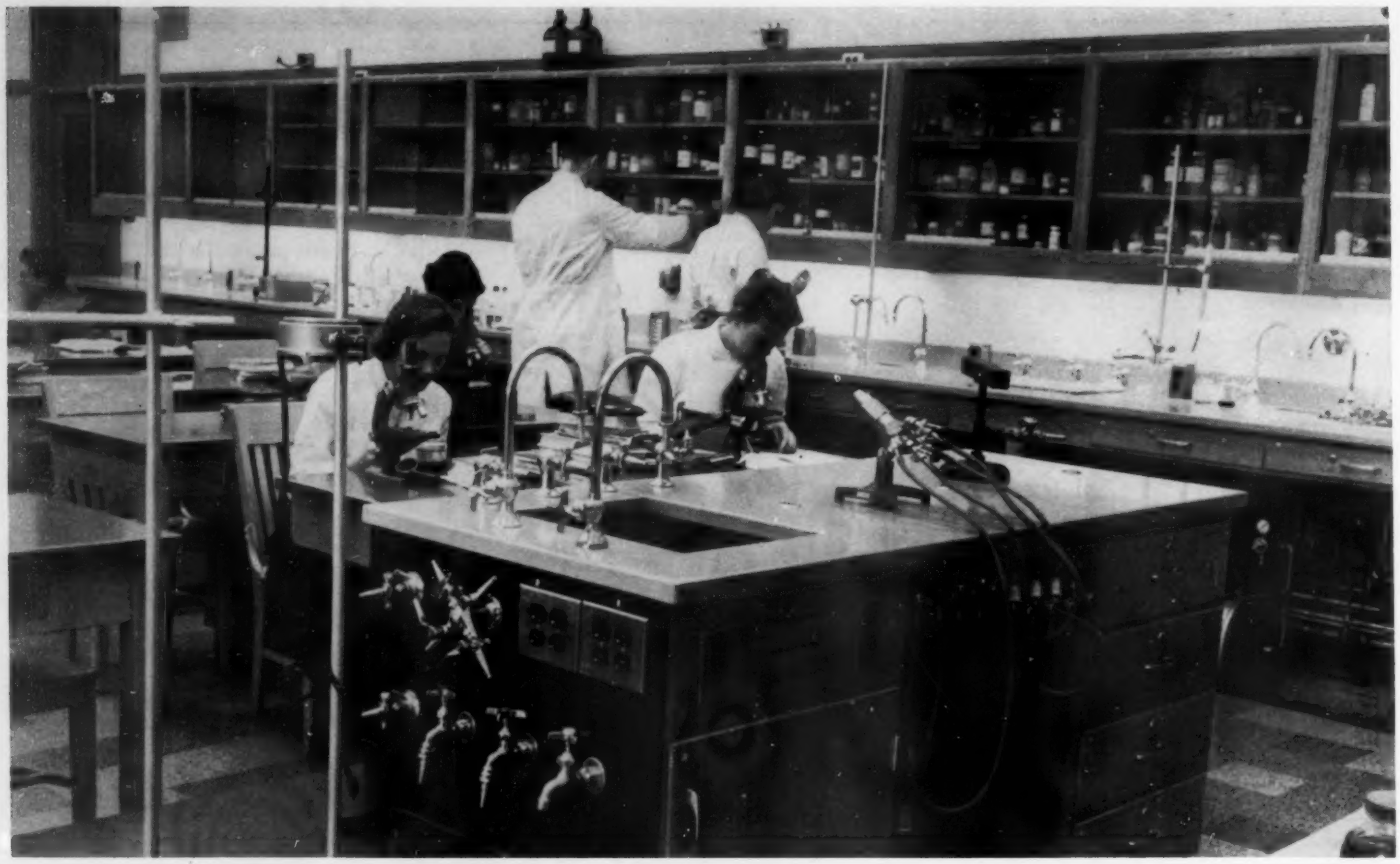
Closed circuit TV station in right background of office and secretarial quarters. Laboratory area and work stations are visible from office quarters.

The base of the fume hood was modified to accommodate a built-in standard kitchen electric oven. The oven has automatic timing and temperature controls. It was chosen instead of a "scientific" oven because of its durability and low cost. This particular oven serves for dry sterilizations (bacteriological and soil), paint drying, and for similar situations requiring dry heat within the oven's temperature range and variation. Other temperature ranges and accuracies are handled by such devices as water baths, chemical ovens, incubators, and a 2400° ceramic oven. All are portable, easily stored, and operate on 117V-AC.

A further modification in the hood base permits storage of the large number of assorted metal rods. A vertically hinged door to the left of the oven provides access to five storage shelves. A case with shelves and a door is located to the left of the hood. Since the hood is at a forty-five degree angle, this particular case "squares it off" with the wall and provides some additional storage space. A special horizontal rack with five openings was similarly placed at the right of the hood. It provides vertical storage of glass rods and tubing of assorted sizes and lengths and is within easy reach of the glassworking center on the demonstration desk.

The office area was made an integral part of the laboratory. Seminar students have always been accepted as part of a working team. As far as possible, the teacher functions as a director of research. Over the years, many delicate seminar projects have been done and left exposed in the biology laboratory; they are never disturbed. In this way, the laboratory is in the spirit of a research laboratory where an individual's work is respected by everyone. These points are stressed because they are the major premises on which the laboratory was planned. Regular tenth-grade biology students live one hour and a half each day in the midst of this equipment and these facilities. Positive impacts and effects upon them are expected to be significant.

Two desks are in the central area of the office. Behind them are counter-high bookcases; wall-hung storage cases are above. In front of the window wall is a research counter with drawers, enclosed storage space, and all facilities. A wall-to-wall drafting center, forty inches high, occupies the wall space opposite the windows. It is equipped with industrial quality instruments, lettering guides, and similar tools. Four built-in desks with typewriter shelves and file drawers are located beneath the window between the laboratory and office areas. Floor conduits carry telephone, 117V-AC, and closed circuit television to the faculty desk area. Spare conduits were installed to ac-



Distillation center and demonstration table with built-in industrial glassworking center. Contains four outlets each for gas, air, and oxygen. Note wall storage and display case.

Private student desks, demonstration table, and distillation stand in foreground. Counter under window contains storage, refrigerator, and live animal section on left.

commodate future needs such as office-lab intercom and background music. Permanent, desk-size, closed-circuit TV teaching components will occupy space between the faculty desk and drafting centers.

A few large storage cabinets were removed from the back of the classroom and a wall-to-wall blackboard was installed. This board is equipped with vertically mounted, industrial drafting instrument which can be moved horizontally the full length of the room. The front blackboard and demonstration table were retained. Drafting materials, a large black globe, and full mathematics models and tools comprise the mathematics center. Beyond these innovations, more versatile classroom facilities were not conceived at the time of rebuilding. Additional remodeling is a future project.

Greater flexibility is ensured in this laboratory through the mobility of most of the equipment. Only the hood, general purpose oven, refrigerator, and distillation and drafting centers have fixed locations; all other items are portable. Portable equipment covers most scientific and technological areas and includes such items as the following:

1. Centrifuges.
2. Full microbiological apparatus — autoclaves and incubators.
3. Electronic and electrical equipment —meters, oscilloscopes, signal generators, tube testers, and assorted power packs.
4. Chemical equipment—piped de-ionized water, balances, Beckman pH meter, Bausch and Lomb electronic colorimeter, and an American Optical Company optical colorimeter.
5. Botanical and zoological equipment —greenhouses, live animal sections, microtomes, and staining equipment.
6. Microscopes—binocular dissecting, oil immersion lens type, research, calibrated micrometer stage and adjustment.
7. Tools — drills, saws, wrenches, grinders, engravers, vises, small anvil, soldering irons, and guns.
8. Supplies—transistors, vacuum tubes, wire, sockets, stains, slides, analytical grade reagents, and media ingredients.
9. Special glassware—cylinders, chromatographic, test, fermentation and separation tubes, volumetric flasks, pipettes, and burettes.

Although these items are enumerated at random, they illustrate the concept of a single operation laboratory. Two aspects, however, could provoke problems of consequence: possible corrosion and excessive noise resulting from improperly adjusted large glassworking burners and torches.

A specially designed typewriter is available for seminar students and faculty members. It is a combination English, mathematics, and chemistry machine with an eighteen-inch carriage. Most desirable characters are available on it. Its features include double sets of numbers for subscripts, exponents, and fractional exponents; symbols such as *pi*, square root, and common Greek; automatic tabulation through 100,000 to a decimal point; and half-spacers.

Advanced Placement Biology is also taught in this laboratory-classroom. Special materials required for this course add advanced materials and equipment to the usual laboratory supply. Because regular biology materials are also present, storage could have been a problem. Several shelf areas with locking doors and over three hundred mixed-size drawers with locks are available. One hundred-twelve drawers are used by biology students; some are used by seminar students; the remainder provide storage.

A rotary file of 2200 cards contains a detailed inventory of all items and their location by numbered drawer and shelf. This file easily locates any item and provides a current inventory. Another rotary file is an indexed catalogue of resource people and industries who can and do provide assistance to seminar students.

Each item of equipment is assigned to one or two students who are completely responsible for its maintenance, use, standardization, and the instruction of others in its use. All persons using equipment must work through the assigned students. A similar procedure operates in relation to special skill and knowledge areas, such as precise bacteriological and analytical chemistry techniques, lettering, vacuum-tube characteristics, and glassworking. In the past, seminar students have possessed such specialized knowledge and skills, but upon graduation, these specialists ceased to exist in the school population. New seminar students had to acquire the skills as needed. Under the present system, before graduation each seminar member trains a junior (eleventh-grade student) to compe-

tence. This innovation is possible with the new laboratory. The cumulative effects over a period of several years could be startling. Every evidence supports the belief that learning, personally acquired under self-motivation, possesses both a richer and a more creative quality than can be obtained through teaching methods alone.

Available laboratory equipment permits a degree of precision unique for high school students. Any and all of the equipment is available not only for project work, but also for class use. For example, when the biology text refers to the range of human hearing, the teacher can assemble the audio signal generator, components, and central speaker system and test the class. When reference is made to concentration of chemicals, materials can be added to the de-ionized water and tested with the colorimeter. Ranges and nature of pH can be demonstrated electronically. Seminar students can do part of their teaching on TV. Most of the potentialities of the laboratory-classroom remain to be discovered.

A distinct value has resulted from students working individually and in groups on all areas of mathematics and science: they acquire the capacity for overcoming compartmentalization resulting from course work. Thus, a student working in biology can evolve a mathematics-chemistry-electronics-biology project. Interrelationships become common, so much so that they cease to be interrelationships; they properly become relationships.

Facilities in this laboratory-classroom are compact. The walking distance between the laboratory teaching area, the office, and the classroom teaching area is no more than thirty feet. All related equipment is housed together. No curricular changes accompanied use of the new laboratory.

Finally, a laboratory should be a pleasant and cheerful place to work in. Particular attention was given to the use of colors. All furniture is finished in gray oak. The floors are of three-hued, cork-textured tile laid in a random pattern. The ceilings are of acoustical tile. The upper half of the walls are a bright yellow; the lower half are nomad gold, a yellowish-olive shade. Students' desk tops are a sharp green and the research counters are a mild gray. The result is colorful, with a pleasant and stimulating atmosphere.

FACILITIES FOR THE ELEMENTARY SCHOOL SCIENCE PROGRAM

By GEORGE E. RAAB and JO SOPIS

Principal — Laboratory Instructor

Heathcote Elementary School, Scarsdale, New York

HEATHCOTE SCHOOL is a contemporary school plant housing 18 class sections, Kindergarten through grade 5, with an average class size of 22. In addition to the staff of classroom teachers, there are full-time special resource teachers in art, music, health, physical education, library, and skills laboratory; there is a psychologist, an instrumental music teacher, and a shop teacher, each of whom is shared with another elementary school. Each of these special services has a planned space facility in which to function. Because of its functional building design, the school has won national and international acclaim, and articles about it have appeared in such periodicals as *Life* Magazine, *School Executive, Architectural Forum,* and *McCall's.*

Quality in education is dependent on many factors. To mention a few: class size, quality of teaching, level of community support, and amount of equipment and supplies available. In addition to these factors, school facilities—in terms of design, construction, and space—bear a very intimate relationship to the scope and quality of an educational program. Consequently, several aspects of the science program at Heathcote School will be discussed which, it is hoped, will demonstrate how, endowed with proper facilities, imaginative teachers can enrich the program of science for all children.

Each classroom, hexagonal in shape, has four exterior walls of glass which bring the outdoors into the classroom. Changes in seasons, animal life, outdoor sounds, and plant study are a part of each child's life in school. Here is a teacher's account of what occurred in one classroom.

Construction of a Zoo

Two rabbits were donated to a class by a father who was a research physician. When it was evident that babies might be expected, the children counted the days eagerly and watched as the mother tore fur from her coat and filled a small wooden keg to the brim. The children named the rabbits Chocolate, Jumper, Thumper, Honey, Chicky, Fluffy, etc. But where were they to live as they grew older? Also, where were the baby chicks to live which had just

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Nature is a conscious part of every classroom environment.

The courtyard, an enclosed outside space, serves as a perfect laboratory for out-of-door experimentation.

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been hatched? And what about the woodchuck and other animals that visited from time to time! It was quite natural for this class to visualize a zoo right outside of their classroom window! The class made plans. They analyzed the problems that needed to be explored in the construction of a zoo and each class in the school was asked to help. The older children dug post-holes, the younger children cut lumber, and others built homes for the animals to live in—and everyone helped care for the zoo and animals. A zoo was born and, to think—right outside of a classroom window, in constant view.

This became a vitalized experience, adding a tone of excitement to the day-by-day living of boys and girls, largely because of the nature in which this classroom facility relates to the out-of-doors environment.

An out-of-door classroom such as this provides unique opportunities for study and application. One class set up a weather station and knew that it would not be subject to the hazards of vandalism. Another group planted bulbs, and followed their progress, while still another group was responsible for the care of other forms of plant life found in this enclosed outside space. Most exciting was the space station and space ship which came to fruition after many weeks of labor under the direction of the shop teacher.

The skills laboratory, exciting to all children, is a room to which children come for any one of a number of purposes. It is a specially designed classroom operating under the guidance of a classroom teacher who helps supplement the on-going classroom programs. Children who come to the skills laboratory include under-achievers who are slow learners, under-achievers of average and high potential, average achievers with varying interests, high achievers with low interest thresholds, and high achievers with dynamic interests. The children come to the laboratory in groups of from four to eight children for about forty-minute periods. In addition, children come in to work during recess periods and after school. The program is time-structured, but individualized and geared to changing interests. It contains reading, mathematics, written language and handwriting, nature, creative writing, and—science, which is perhaps the most exciting part of this program. The skills laboratory teacher illustrates the par-

ticular activity which is made possible by this facility:

Two boys came to school and one began to discuss his brother's "ham" radio station. Both boys became enthusiastic and asked the teacher if they might build a radio or "do something in electronics." The teacher suggested that they make an appointment with the skills lab-teacher and discuss their interests. It so happened that two pieces of equipment had been sent to the laboratory for evaluation by a manufacturer: an analog computer, and the "Brainiac." This was a perfect opportunity for these two boys to begin to pursue their interest in electronics.

In the late fall, the young birds (swallows, sparrows, juncoes) flying about the school sometimes crash into the glass windows, are stunned and

The skills laboratory, a space where a special service can function in a dynamic and realistic manner.
HEATHCOTE SCHOOL, SCARSDALE, N. Y.

even killed. Children search the grounds daily for these accident victims and bring them to the laboratory and the nurse. The children care for the birds, identify them, and plan ways to avoid the same occurrences. Later, the birds are taken to the courtyard where they can fly about in a protected place until they are able to leave.

Having such a space facility makes it possible for many children to explore science experiences which would otherwise be impossible.

The art program is closely related to science activities in the classroom. The shop program also supplements science study in the classroom. Grades K through 5 receive shop instruction. They plan projects, choose appropriate materials, and execute necessary jobs. A fifth grade might require small cages to house some white mice, in order to conduct experiments in feeding different foods to the mice and trace weight loss and gain. The cages are made in the shop room. Or, a fourth-grade group might want to build a maze to study how white rats learn. The shop teacher will help this group proceed with the experiment. Again, a group in a skills laboratory might be breeding guinea pigs and discover that they need a large cage with a built-in shelf under which the mother can hide. The shop would facilitate such a project.

Children and teachers alike use the library and the curriculum materials room. The library-resource teacher provides scheduled periods of instruction in library techniques, study and research methods. In addition, the librarian serves as a resource person to children and teachers. Whether a class is studying a unit on glass, or developing a unit on great rivers, she makes available books, charts, and equipment appropriate to the topic. Many times, films, filmstrips, and other visual aids can be previewed and evaluated in the curriculum materials room, where children have an appropriate space for this kind of activity.

A useful space in the school is one in which all children can come together to widen and deepen their interests, to develop self-expression, and to participate in a socializing and unifying experience. Given such a space, many are the opportunities to stimulate important science learnings. Recently, a demonstration and explanation of an eclipse was given in the auditorium. (An actual eclipse was witnessed the same day in the early morning hours.) This facility in the school made it possible to capitalize on a real-life experience in a useful and economical fashion.

Heathcote School has a twenty-two acre outside habitat where children can see wild flowers by taking a hike through the woods, where they can study erosion and other effects of climate, and where they can study the habits of wild life. The greenery on the grounds consists of the customary varieties of deciduous and non-deciduous trees and flowering and non-flowering bushes. Heathcote children are in constant contact both visually and physically with natural foliage. One teacher reports:

> The children were curious as to why grass did not grow in the two-foot space immediate to, and surrounding, their room and they decided to plant a garden in that space. Avidly they fertilized, spaded, and planted. The ground was watered, and observed through the windows. They learned about erosion as the rain and snow falling from their overhanging roof washed the good, rich soil away, sometimes even exposing their bulbs.

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Auditorium—center for exchange of ideas and experiences.

Experimentation in elementary science is precipitated by such facilities.

Present plans are for a projected science park on the grounds, where a large garden and greenhouse, and many other kinds of science activities can be made possible only by having such space. One day there might be a miniature railroad, designed and built by parents and children, operated and maintained by children.

It is often said that superior teachers will teach well in a barn. It is equally true that superior teachers will be even more effective given the proper tools and facilities with which to work. More important, children learn best in a physical environment which is stimulating and properly related to the purpose at hand. It is hoped that this article illustrates the role which physical facilities can play in a science program for children. At the same time, let's not forget—creative teaching is the only means by which we capitalize on any physical resources for science.

FACILITIES AND EQUIPMENT AVAILABLE FOR TEACHING SCIENCE IN PUBLIC HIGH SCHOOLS 1958-1959

The research reported herein was performed pursuant to a contract between the University of Toledo and the U.S. Office of Education, Department of Health, Education, and Welfare. The views expressed in this report are those of the author only.

By CHARLES L. KOELSCHE

U. S. Office of Education, Washington, D. C.

SINCE the early thirties, considerable emphasis has been given to the so-called "social aspects of education" while, in the opinion of some educators, businessmen, and professional people, too little time has been devoted to the study of subjects in certain academic areas. Relationships between human experience and science have become so closely allied that today an educated person cannot afford to be without some knowledge and understanding of science.

Improvement of science education programs in the public high schools of the United States is necessary if we expect to close the gap between the public's knowledge and understanding of science and the achievements of science. Science teachers in these schools are in a strategic position to locate, stimulate, and nurture young people with capabilities toward careers and leadership roles in science and technology. The adequacy of science facilities and equipment is an important factor in this situation.

This project on science facilities and equipment was concerned with: high school and science enrollments; science offerings; the nature of room and laboratory facilities for the teaching of science; fiscal arrangements for and administrative practices employed in the procurement of equipment and supplies; sources of borrowed and donated equipment; and the quantity of demonstration and laboratory equipment available for teacher and student use.

Data were collected firsthand by visiting 855 high schools selected at random in Florida, Illinois, Massachusetts, North Dakota, Ohio, South Carolina, and Wisconsin.

Science Teaching Facilities

There were 1988 rooms used for science instruction in the 855 high schools. The average number of such rooms per school in the four enrollment categories was: 1-199, 1.2 rooms; 200-499, 2 rooms; 500-999, 3.3 rooms; and 1000-up, 6.8 rooms.

The most prevalent types of rooms used by high school science teachers were combination classrooms and laboratories (multipurpose rooms) equipped for teaching one science subject and combination classrooms and laboratories (multipurpose rooms) equipped for teaching two or more science subjects. In approximately one-fifth of the schools, science was taught in regular classrooms. Separate classrooms and laboratories designed for teaching a single science subject and regular classrooms equipped with movable lecture-demonstration tables were found less frequently.

Small high schools tended to use more combination classrooms and laboratories equipped for teaching two or more science subjects, while the large schools tended to use more combination classrooms and laboratories equipped for teaching a single science subject.

Ninety per cent or more of the high schools had the following presentation facilities in their *science classrooms*: chalkboards, AC-electrical outlets, picture projection equipment, running water, bulletin boards, lecture-demonstration desk, and gas outlets. Fewer than 30 per cent of the schools had science rooms containing elevated seating or elevated lecture-demonstration desks, DC-electrical outlets, and compressed air outlets.

Seventy to ninety per cent of the high schools had the following science facilities in their *laboratories:* AC-electrical outlets, storage cupboards, gas outlets

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NOTE: Since this report was submitted, the author has accepted an appointment as Special Assistant to the Director, Office of Scientific Personnel, National Academy of Sciences-National Research Council.

on each desk, running water and a sink or trough on each table or desk, separate storage-supply rooms, and student equipment lockers. Fifty to seventy per cent had window and wall shelves, running water in laboratories but not on each desk or table, reagent and/or storage shelves, and fume hoods. DC-electrical outlets and compressed air outlets were available in laboratories of less than 25 per cent of the schools.

An evaluation of science teaching facilities showed that most of the high schools had adequate lighting and ventilation in science classrooms and laboratories. Stockroom storage facilities were adequate in 65 per cent of the schools. Laboratory space per student was adequate in only 46.6 per cent of the schools.

The location of science classrooms and laboratories was such that minor enlargement and modernization were feasible in 45.5 per cent of the high schools.

The over-all rating of science teaching facilities compiled by the state committees at their final meetings was: good for 28.4 per cent of the high schools; fair for 36.5 per cent; and poor for 35.1 per cent.

General Provisions for Science Equipment

Fifty-eight and nine-tenths per cent of the 855 high schools had specific annual budgets for procuring science equipment. For the 1958-59 school year, the total funds provided by these budgets were $451,358. Since 503 schools had budgets, the average amount of money available per school was almost $900. In comparing these allotments with those for the preceding year, it was found that they represented an increase for 51.3 per cent of the schools, no change for 32.8 per cent, and a decrease for 15.9 per cent.

Annual budgets for science supplies were found in 443 or 51.9 per cent of the high schools. These funds totaled $169,488 and thus the average per school was $382. When compared with the amounts budgeted for 1957-58, these allotments represented an increase for 39 per cent; no change for 49 per cent; and a decrease for 12 per cent of the schools.

High schools not having budgets specifically earmarked for science used funds from other allotments to purchase some science equipment and supplies. Accurate estimates of the amounts thus spent were so fragmentary that it was impracticable to consider them.

By combining all budgeted funds for high school science equipment and supplies allotted for the 1958-59 school year, and dividing the sum by the total number of students enrolled in all science classes, an average of $2.66 per science student was available ($620,846 divided by 233,544). A further breakdown of funds according to school size showed that in the 1-199 enrollment category, the average allotment per science student was $3.90; 200-499, the average was $2.88; 500-999, it was $2.50; and 1000-up, $2.26.

The over-all ratings of science equipment showed that chemistry equipment was judged best, general science second, biology third, and physics poorest. In terms of good, fair, and poor, chemistry was rated fair plus; general science, fair; biology, fair minus; and physics, poor.

Quantity of Equipment

Data in the equipment inventories, made by members of the state committees, were utilized to determine the number of each item available per school, per classroom—when significant, and the number of science students per item. Moreover, the portion of high schools not having certain items of science equipment and the number of students in these schools were determined.

There were 33 items listed in the general science inventory; 9 in the biology student locker list, and 41 in the general biology inventory; 32 in the chemistry student locker list, and 38 in the general chemistry inventory; and 220 items that were listed in the physics inventory.

A considerable variation was noted in the quantity of science equipment available and the number of science students per unit in the various sizes of high schools. As the size of the schools increased, the variety of items and the number of each item also increased. Even though the large schools had a greater number of science students per item of equipment than the small schools, they had several class sections of each science subject, so the net number of students per item decreased substantially as school size increased.

The per cent of high schools in which the various items of science equipment were absent was generally the highest in the small schools and the lowest in the large schools. A smaller portion of science students in the large schools was thus deprived of firsthand experiences with science equipment than in the small schools.

The equipment listed in the inventories was, in some instances, missing completely at the high schools. The tabulation below gives statistics on this for the four traditional science courses.

Semi-micro laboratory equipment was available in only 10.2 per cent of the 636 high schools offering chemistry during the 1958-59 academic year.

Some Generalizations

Combination classrooms and laboratories (multipurpose rooms) are becoming the most popular type of facility for science instruction, thus replacing the traditional separate lecture and laboratory rooms so common during the first half of this century. Entirely too many high schools, however, were still using regular classrooms for

TABULATION OF EQUIPMENT SURVEY

Course	Number of high schools in which *none* of the items was found	Size of School: 1-199	200-499	500-999	1000-up
General Science	27	12	10	3	2
Biology	9	7	1	0	1
Chemistry					
(Student lockers)	103	75	16	6	6
(Gen. lab. equip.)	28	24	2	1	1
Physics—Items 1-35	28	23	3	1	1
36-72	87	60	22	4	1
73-109	71	50	18	2	1
110-146	72	52	17	2	1
147-183	81	56	22	2	1
184-220	71	50	17	3	1

science classes because their facilities did not include enough rooms equipped specifically for science work.

Many science classrooms and laboratories were inadequately equipped for effective instruction. In a number of schools, it was noted that facilities and equipment were geared to the academic background and interests of the present or past instructor(s). They were good in their major field(s) of interest but woefully weak in other areas. High school administrators have a responsibility to see that a reasonable balance of equipment and supplies is maintained for the various science classes.

A definite relationship exists between the size of school and status of the facilities and equipment for science instruction. Large high schools as a group had better presentation and laboratory facilities and equipment than the small schools.

Since roughly one-half of the high schools lacked adequate space for laboratory work and one-third of them lacked proper science equipment storage facilities, every effort should be made by school administrators and the local school trustees to rectify these conditions. The location of science classrooms and laboratories was such that minor enlargement and modernization were feasible in approximately one-half of the schools.

Roughly six out of every ten high schools had annual budgets for procuring science equipment, and about five out of ten had annual budgets for science supplies. For the 1958-59 school year, these funds totaled $620,846. When compared with the 1957-58 total allotment, it represented an increase in 46 per cent, no change in 40 per cent, and a decrease in 14 per cent of the schools.

Even though the per cent of high schools having budgets and the amount of appropriated funds increased as school size increased, the amount per student decreased as school size increased. The over-all average, based upon total science enrollment in the 855 high schools, was $2.66 per student. This amount is equivalent to the price which we now pay for ten packages of cigarettes!

According to the reports submitted by the investigators, there were many non-academic programs in the schools visited for which adequate or generous funds were available per student participant, whereas funds for science education were meager and obviously inadequate in the same school. Science teachers should be able to depend upon an appropriate amount of money each year for the procurement of equipment and supplies. This would permit long-range planning and a steady improvement in the variety and quantity of laboratory and other instructional equipment. A guaranteed basic allotment per science student is one effective way by which projected budgets can be estimated.

Assuming that one of the school's important functions, probably the unique one, is academic in nature, administrators should provide first for adequate financing not only of science programs but of all academic programs, and secondly for non-academic ones.

As conventional fuels and the "Iron

Age" give way to the atomic and space era, can the American people, the elected school trustees, and school administrators expect science programs to keep abreast of the times when annual budgets were provided in only 59 per cent of the high schools; when the amounts provided in one-half of the schools represented no change or a decrease from the preceding year; and when about one-fifth of the schools required science students to pay breakage and laboratory fees?

The need for adequate science budgets is enhanced by the fact that a relatively small number of high schools were recipients of funds from out-of-school sources and of donated or borrowed equipment. Except for Federal Surplus Property, these sources contributed only meager amounts of funds and equipment. Almost six schools in every ten, however, were making extensive use of improvised equipment.

A change in the procedures used for procuring science equipment and supplies could result in a more efficient use of available funds. Many high schools still permit teachers and administrators to make purchases directly from supply houses. Only 10 per cent of the schools pooled their orders and submitted them to suppliers for bids; yet this technique is used by most business concerns.

If science teachers are going to be effective in bringing about an improvement in science education programs in the high schools, they must be allotted special time for doing some of the added duties associated with their positions. These duties involve the keeping of an up-to-date inventory of science equipment and supplies—such an inventory was available in about one-half of the high schools; setting up equipment for demonstration and laboratory work; and maintenance of equipment. Time for these latter two duties was provided by 34 and 18 per cent respectively of the schools. A portion of the needed time could be obtained by eliminating all duties unrelated to science teaching from the assignment of science instructors.

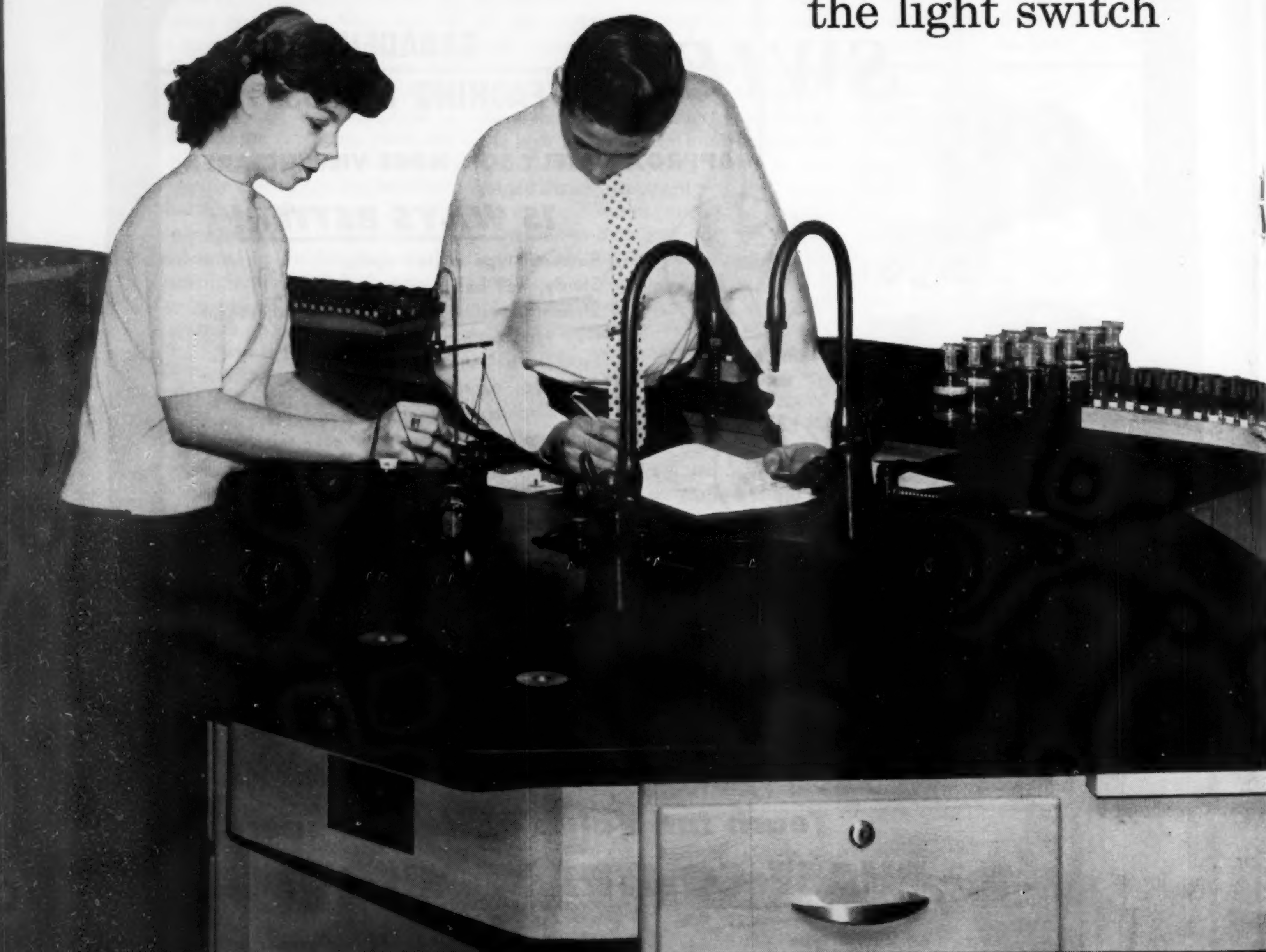
Basic items of equipment were missing more frequently in schools enrolling fewer than 200 students than in those with enrollments of 500 and above. Many investigators, including Dr. Conant, indicate that schools enrolling fewer than 500 students cannot offer the educational opportunities present in the larger schools. Every effort should be made, therefore, to bring about a consolidation of small high school districts, thereby broadening the base for adequate financing of the total school program. Equal educational opportunities for all American youth would thus move a step closer toward ultimate realization.

A greater portion of high school students is studying science today than three years ago. This is discernible from the following tabulation:

Subject	U. S. Office of Education Study 1955-56	1958-59
	Per Cent	
Biology	20.3	24.5
Chemistry	7.6	10.2
Physics	4.6	5.6

A copy of the complete research report may be obtained by sending 25¢ in coins to cover mailing costs to the Research Foundation, University of Toledo, Toledo 6, Ohio.

It seems only yesterday they couldn't reach the light switch



The Elementary School Science Reporter

Equipment and Supplies for Elementary Science

By HAROLD E. TANNENBAUM

Professor of Science Education, State University College of Education, New Paltz, New York

As teachers have recognized the active nature of elementary school science, the need for equipment and supplies for teaching such a program has become more evident. Since the National Defense Education Act funds have become available, budgets have been increased, and the purchase of science materials has become less of a problem for teachers and schools. Funds, however, are still difficult to obtain. Not long ago, a teacher was heard to complain: "Why don't they give the physical education teacher a piece of canvas and tell him to go home and have his wife sew up a football. It makes just as much sense to do that as to ask me to go home and use odds and ends to make a galvanometer."

Miss Velle Toney, Senior Elementary Consultant, discusses the science cabinet with Mrs. Arianna Sims and Mrs. Geraldine Patterson, chairman of the first-grade group.

Currently, the questions of what to buy, how much to buy, and how to make sure that the purchases are used to the best advantage become as important as questions of how to get necessary allocations of funds. Many procedures for equipping elementary schools for an active science program have been carried out recently in various parts of the country. At Columbia, South Carolina, an interesting and fruitful project was begun.

According to W. Clark Brockman, the Coordinator of Elementary Instruction, the story goes back more than ten years. Late in the 'forties, scores gathered from standardized tests in elementary school science indicated that the Columbia schools "were somewhat below the national norms in science." At that time, a new program was instituted and for the past four years, Columbia's scores have been well above the national norms. But the Columbia teachers have been far from satisfied. While the children have "done well on the tests" the program has not seemed to promote such attitudes as "the reserving judgment, the evaluation of all the evidence, the discovery of truth."

A study of the situation revealed a possible cause. Mrs. Theo Hartin, one of the elementary school consultants and a recognized authority on conservation and on wild life of South Carolina, examined many of the elementary school science lessons. The teachers were good, conscientious, hard-working people. But the teachers were omitting science activities. Mrs. Hartin found that even those experiments which called for nothing more than a glass or a bottle or a jar were discussed and described, but were not attempted at any time.

What to do? Taking on this problem of science teaching as her project, Mrs. Hartin analyzed the three basic science text series which could be used in Columbia. She then prepared a list of all of the science materials needed to conduct every experiment in every one of these texts. The list was divided into two parts—those items that would need to be purchased, and those items which might be obtained in homes or in school. Originally, the list was distributed to the principals of the elementary schools of Columbia with the hope that they would utilize their individual school budgets for purchasing these supplies. (Columbia has a policy of allowing individual schools considerable latitude in the way per-pupil supply funds are expended.) But, with the enactment of NDEA Title III, funds for science equipment were doubled and it was decided to use these to provide each school with the essential equipment that was needed for the basic science program.

The list of materials had already been prepared, but the problem of storage arose as soon as attempts were made to supply the schools. The solution seemed to lie in a large, centrally located cabinet with plenty of room for basic equipment as well as for items to be included later as teachers found need for such additional materials. Furthermore, a large cabinet would mean an assigned place for each item, visible, and easy to remove without moving other things. And finally, the cabinet would mean that a teacher would take only those items that were needed for a particular experiment, leaving all other materials available to other teachers. A committee consisting of Mrs. Hartin and Roy Ellis, the principal of one of the schools and an excellent science man, did the final designing. The cabinets were built during the summer in the school shops and were equipped and installed in each school ready for use on the opening day in September 1959.

But there was much more to the program than simply putting a science supply closet in each school—important as

Discussing school policies and practices concerning the science cabinet are W. J. Castine, Principal and Chairman of the City-wide In-service Training Committee; Mrs. Patsy Scott, librarian and custodian of the cabinet at Bradley School; and Mrs. Theo Hartin, Elementary Consultant and Chairman of the City-wide Science Committee.

Miss Paula Boltin, fifth-grade teacher, receives contributions from students for the room's "apple box" science kit.

Dr. Paul Blackwood, U. S. Office of Education, emphasizes some of the essentials to sixth-grade teachers Mrs. Mary Mace (chairman), Alvin Shaw, and Mrs. Mignon Whittinghill.

Miss Dorothy Ropp, third-grade chairman, clarifies a few points for Mrs. Helen Wise (left) and Miss Eugenia Burnett (right).

In the workshop session, Mrs. Mary Jane Coxe, sixth-grade chairman, explains the theory to Mrs. Helen Weed while T. C. Bruce makes the application.

that was. As part of the plans made in the spring of 1959, Mrs. Hartin appointed a subcommittee on teacher training. W. J. Castine, one of the school principals and the chairman of the subcommittee, prepared for a summer workshop to familiarize the teachers with the materials in these much discussed science cabinets. Two teachers—one from the primary grades and the other from the intermediate grades—were chosen to represent each school at the workshop. Dr. Paul Blackwood of the U.S. Office of Education and T. C. Bruce, the science supervisor for the South Carolina State Education Department, served as consultants for the workshop. Experienced teachers who had been doing superior work in elementary school science served as grade-level chairmen. In these meetings, the ways in which the materials in the supply closets could be used were explored and considered. Suggestions were made for individual class science-boxes to supplement and extend the materials to be found in the supply closets.

But the most interesting part of the whole experience came after school opened in the fall of 1959. By the end of September many building meetings had been held. These became informal workshops in which the two school representatives led other teachers in an exploration of the items to be found in the supply closets. The individual class science-boxes — the "apple-box cabinets"—which had not been too successful when they were introduced previously, were brought out and re-examined. Soon these began to be filled with important items which each classroom needed, and the children were the ones who took up the challenge most vigorously. Morning after morning they appeared (and are continuing to appear) "with items for real science" to be added to the classroom "apple-boxes."

There is no one more able to summarize this program than Mr. Brockman who says: "We believe that making these materials easily available, giving our teachers encouragement, and a measure of confidence in their use, is going to make quite a change in the brand of science instruction found in our schools."

A Common Denominator for Scientific Problem Solving

By W. C. VAN DEVENTER

Chairman, Department of Biology, Western Michigan University, Kalamazoo, Michigan

THERE is little question but that critics of the existence of a well-defined "scientific method" are in some measure correct. New knowledge undoubtedly could be discovered and tested thus formally, but probably not much of it actually has been. Those who go to the other extreme, however, and magnify the part played in scientific discovery by "hunches," lucky accidents, and other semi-intuitive and haphazard procedures, go much too far. People do not solve their daily life problems in this way; neither do scientists.

There is unquestionably a common denominator of scientific procedure between the formalized extreme which is idealistic and unreal, and the opposite extreme which denies the existence of any underlying logic. Scientific methodology is only a systematized aspect of ordinary, logical problem solving which is used by every normal person in meeting the problem situations with which he is confronted every day that he lives.

The operation of this method of problem solving may be described as follows: An individual is confronted with a new situation, or with a modification of an existing situation, such that a challenge is presented. The individual surveys the situation as well as he can. He draws on his past experience and that of others for whatever may bear upon his problem. Then he sets up one or more tentative solutions and tries out the most promising one. If the solution is successful, he goes on his way, the problem solved. If it is not successful, he adds the result of the unsuccessful attempt to his experience, and on this basis sets up a new or modified solution. He repeats this procedure again and again, if necessary, until either he finds a workable solution or concludes that one cannot be worked out. In the latter case, he "tables" the problem and lives around it as best he can.

Once a solution is reached, it is re-used whenever the same or a similar problem arises. Affinities between different types of problems are recognized, and established solutions are utilized and modified as necessary. Such established solutions become conditioned responses, and are the stuff of habit formation. We depart from our habitual solutions only as we are forced to do so, and even then we try to get by with simply modifying them. Not until we have to, do we strike out on a completely new path.

The scientist's procedure differs from this only in the matter of motivation, the nature of the problems dealt with, and the greater care exercised at every point. The scientist may be motivated by curiosity, by a kind of "thirst for knowledge," or by a desire to excel in a particular field of knowledge. Service to mankind may also be a motive. His problems deal with material forces and things, their nature, behavior, and relationship to one another, and the manipulation of them to bring about man's desired ends. These material things can be measured or reduced to measurable terms. They can be weighed, measured, counted, or otherwise quantitatively dealt with. Furthermore, the events with which scientists deal are repeatable, at least in theory. Those which can be readily repeated can be subjected to experimentation described as a kind of observation under controlled conditions. Those which cannot be repeated cannot be subjected to experimentation, and must, thus, be observed as carefully as possible under natural, uncontrolled conditions.

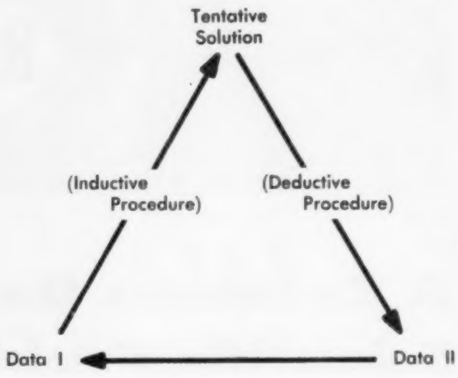
The scientist tends to seek out problems where the lay person generally does not. Once having isolated a problem, the scientist attempts to clarify it and reduce it to its simplest terms. In the matter of setting up a tentative solution, he proceeds with greater formality and exactness than the layman usually does. The scientist recognizes his proposed solution as tentative. He derives it from and relates it to the data at hand. If it serves to explain or deal adequately with these data, he applies it to new data or a new situation of the same or similar type with equal care. The new situation or source of data may be in the form of a controlled experiment if experimentation is possible, or of further observation under natural conditions. If the tentative solution is applicable, then its use is continued, and with each new situation or set of data in which it is successful, it becomes more firmly established.

This basic problem-solving proce-

Articles for this series are prepared under the direction of the committee's chairman, Dr. William B. Reiner, Bureau of Educational Research and Statistics, Board of Education, City of New York. Author credit is given for each article in the series. The committee members serving this year include: Dr. Cyrus Barnes, New York University, New York City; Dr. Sam S. Blanc, Gove Junior High School, Denver, Colorado; Dr. George G. Mallinson, Western Michigan University, Kalamazoo; Dr. John S. Richardson, The Ohio State University, Columbus; Miss Edith M. Selberg, Colorado State College, Greeley; Dr. Herbert A. Smith, U. S. Office of Education, Washington, D. C.; and Dr. Nathan S. Washton, Queens College, Flushing, New York.

dure of science is summarized in the accompanying diagram (Figure 1).

It is shown by following the diagram that the essentially inductive procedure of arriving at a tentative solution on the basis of the data at hand is differentiated from the essentially deductive procedure of applying it to new data or a new situation. By presenting this analysis as a kind of "least common denominator" of all problem solving and showing it to be equally applicable to the problems of everyday living and those of science, students can be brought to a better understanding of science and the work of the scientist.

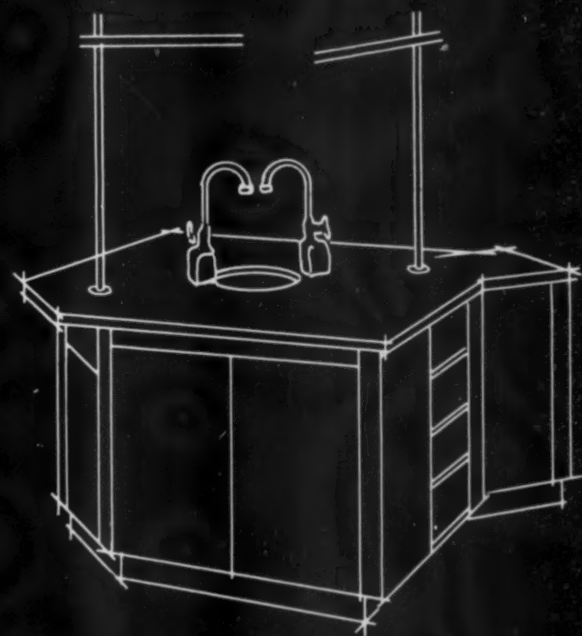


If tentative solution does not work, return to Data I, add Data II and proceed with a new or modified tentative solution.

FIGURE 1. Cycle of Proof

NOTE: For a more detailed presentation of the point of view stated here, see W. C. Van Deventer, "A Simplified Approach to the Problem of Scientific Methodology." *School Science and Mathematics,* 58:97-107. February 1958.

THE SUBJECTIVE LABORATORY



By JAMES A. ROSSAS

Physics and General Science Teacher, Oroville Union High School, Oroville, California

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

SCIENCE TEACHERS may have brought their courses up-to-date by a unit on satellites, but have they brought the absolutism of the nineteenth century text down to earth? Margaret Mead and Rhoda Métraux suggest ". . . more participation and less passive watching in the classroom, less repeating of experiments the answers of which are known . . ."[1] Lester Grant[2] stresses the paradoxical nature of a modern scientific problem; yet, very few school texts admit the possibility of the paradox to one well versed in the subject. Not only does the text give the idea that the law in italics or bold type is absolute, but even the laboratory is now unquestioned and has become monotonous.

Today the science teacher has laboratory manuals of all types, from the hard-bound to the fill-in-the-blanks type. Each of these contains certain more or less standard experiments which have varying degrees of meaning to the student. Do any of our stock experiments, however, really teach modern science? Has the science teacher fallen in with the technology and ignored the science? This case is indicated by Elbert P. Little, executive director of the Physical Science Study Committee,[3] and is evidently the basis of that group's current physics curriculum revision.

Perhaps one element which differentiates science and technology is creativity. Harold Gershinowitz in "The Drive to Create"[4] states "the accelerated development of the sciences and the useful arts has built up a pressure to increase not only the numbers of research workers but the very pace of creativity." He then goes on to ask ". . . what environment will stimulate creative process?" Knowing the rank-and-file science experiment, one could continue: do we even attempt to introduce creativity into the laboratory? And, if not, how can this be done in the conventional American high school?

The introductory chapters of almost any science text will list a series of steps in the scientific method. Presumably this preamble is to set the method of the course. Whether it does or not, is not the question here, but whether the list is complete is suspect. Great detail is given to problem statement, hypothesis examination, experiment, control and conclusions; but the insight is glossed over. Hypotheses and experimental designs appear miraculously. Of course, the logical reason is that creative insight cannot be taught, or rather written out and memorized as a set of rules. Opportunities for its use, however, can be presented and exercised in various degrees by the students. It is the purpose here to show how creativity of different levels may be introduced and tested in an average high school physics laboratory, not one for gifted students.

Possible clues to creating the insight environment would include thinking along the following lines: (1) use of analogy, even extended to fantastic

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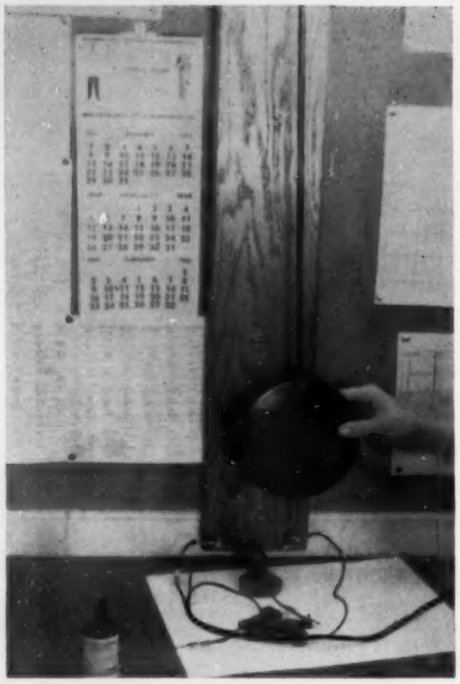
[1] Margaret Mead and Rhoda Métraux. "Image of the Scientist among High School Students" [A Pilot Study for the AAAS]. *Science*, 126:384-90. August 30, 1957.

[2] Lester Grant. *The Challenge of Cancer*. U. S. Department of Health, Education, and Welfare. 1950. p. 1-5.

[3] E. P. Little. "The Physical Science Study: From These Beginnings." *The Science Teacher*, 24:316-9. November 1957.

[4] Harold Greshinowitz. "The Drive to Create." *The Atlantic*, 200:101. October 1957.



Solving for "g" by the traditional pendulum.

limits, (2) random, or trial and error hypotheses, and arbitrary graphing of variables, and (3) reduction of a physical system to a mathematical model. Research into previous work is a corollary since an extension of knowledge is needed in all the above.

Realizing that every physics student is not ready to assume initiative without some guidance, the following evolution has been contrived and used for seven years:

Playing the modern Galileo proved to be an inaccurate second value.

1. The clues to insight mentioned above are presented, and some illustration of the use of each is given.
2. If it seems necessary, the laboratory manual is introduced for the first experiment. Certain changes, however, are recommended first by the instructor, then by the students. These revisions consist of possible short cuts, or methods for improved accuracy. In sectioned groups this stage is often omitted.
3. After the introductory period, the manual is discarded and a short outline of laboratory objectives is given by the instructor with procedure left to the student. By now, students should have had enough time to become familiar with the available equipment. The instructor can acquaint the students with facilities not otherwise obvious. (Incidentally, the freedom allowed does not seem to have any effect on breakage in our case. The accident prone, however, may well be noted.)
4. In the second or third month of the term a laboratory test is given on simple and compound machines. The test could be adapted to other subjects just as well. After giving the definitive equations on mechanical advantage and efficiency and some study of the subject in the text, the student spends twelve minutes on each of four laboratory problems. The instructor must contrive as many items as there are students in the section, and each student must take one item in each of four rows or groups. All of the items in each group should be of approximately the same difficulty. Items generally consist of machines from the home economics and industrial departments, such as vises, egg beaters, meat grinders, and drills. Along with each device is a written problem asking for efficiency, ideal mechanical advantage, etc., which the student must evaluate by his own means. Out-of-class time is given for the calculations.
5. Many of the experiments after the test concern verification of laws or principles and calculation of percentage differences between calculated and experimentally determined values.
6. The method of the preceding section is extended to show sources of error and methods of correcting them. The procedures of various people will differ throughout the year. Many students find the methods of proportion a valuable key.
7. The last stage gives the student time for experimentation which he may spend as he wishes. It is not to be implied that all students arrive at this stage, and at no time is everyone at the same point. The test is given to all at the same time.

Reporting

All of the experiments must be reported in a logical, written form. The length varies from one-page omnibus experiments to fifteen pages of description. The length of an experiment and its accuracy or originality do not seem to be dependent factors.

The student early discovers the importance of the time element. If the laboratory work is not completed in the work period (very often several days in succession are allotted in preference to isolated periods), the students know

A "harder" case with three dimensions, but without moments.

that the laboratory is open to them before school, at lunch hour, and after school. Very often it is in this extra time that the student gets the feeling that it is his unique experiment. Sometimes the original experiment is discarded for a better method.

Superimposed over the entire course is a bold step toward creativity. The student is asked to choose a topic very early in the course. He is then assigned the task of mastering the elements of his topic well enough to become the class expert in that particular field. He is always allowed to select his field of study, as most students choose broad topics in the early part of the course. His research takes him outside the school for literature; to colleges, local experts, or to other authorities. Any material sought in this way must be

worth the time of the person consulted; hence, the questions must be specific questions with answers not available in any of the common references. The project culminates in a report which applies the subject to a specific new situation; criticizes a known method; and proposes a substitute, or designs an experiment to enlighten the next step in the field. In general, the correspondence and interviews with experts have been favorably received by firms, agencies, and individuals, as long as the questions are specific and sufficiently advanced in nature. The link that the project presents between formal high school education and a career in science makes the step into college courses much more logical. All projects must be carefully corrected by the instructor. Criticism is necessary since the student should not be deluded into thinking that the project is of greater value than it really presents. Grading rests mainly on the analysis of the subject by the student and the originality of his work. Critical evaluation of all the written work should give a realistic picture of all creative abilities.

The next step, now being considered, is inserting a formal experiment in the beginning of the course which would involve direct use of subjective probability in a physical situation. Paul DeH. Hurd in "The Case Against High School Physics"[5] argues that the course will cease to exist unless it is modernized. With the present talk of crash education, it seems that annihilation of the course is improbable. Since subjective probability,[6] however, is a major tool in modern physics, psychology, and genetics, why not introduce it into high school? There are those who will argue that this suggestion will deflate the absolute determinism unique to the high school stage of science.

An argument against the whole program shown above is the fact that the grades must be subjective, and open to debate. This brings us to the title, "a case of and for a subjective laboratory." Is it not the objectivity of grading which leads the instructor to standardize the laboratory experiments and unconsciously eliminate creativity?

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[5] Paul DeH. Hurd. "The Case Against High School Physics." *School Science* and *Mathematics*, 53:439-49. June 1953.

[6] John Cohen. "Subjective Probability." *Scientific American*, 197:128-38. November 1957.

UNITRON student microscopes offer

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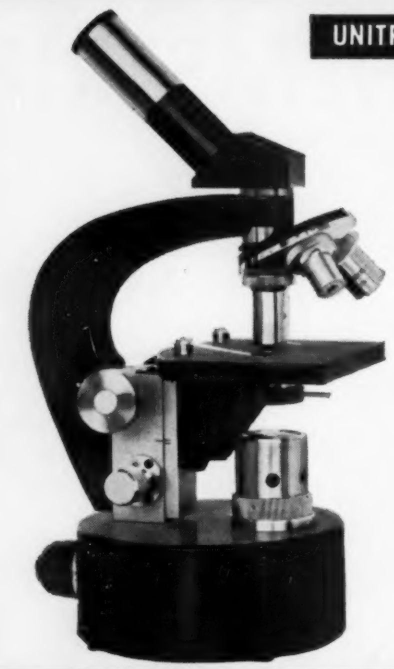

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TEACHING SCIENCE IN THE MONTANA SENIOR HIGH SCHOOLS

By **DONALD C. ORLICH**

Butte Junior High School, Butte, Montana

and **PAUL J. HANSEN**

Department of Education, University of Utah, Salt Lake City, Utah

ONE of the questions that commands much attention of science teachers is that of how to teach, or in short, "method." What is the importance of method in science teaching? Few broad studies have been made of this aspect of science teaching. One such study was made of the methods of teaching science in the senior high schools of Montana.[1] Perhaps science teachers throughout the country might benefit by studying the results of this research of the methods used in Montana.

The purpose of the original study was to make an appraisal of the methods of teaching science in the senior high schools of Montana. The method of selecting information was through a normative survey, using an eight-page questionnaire which was sent to Montana science teachers. The questionnaires were mailed to one teacher, selected at random, in each of the one hundred ninety public and private Montana high schools. The number returned was 155 or 81.5 per cent of the total. This accounted for 40 per cent of all science teachers in the state. All data reported herewith pertains to the polled group.

Administrative factors. 1. The teachers' evaluation of the science equipment was as follows: 3 per cent thought that their equipment was "more than adequate," 42 per cent had answered "adequate," while 55 per cent replied "inadequate."

2. School budgets included science equipment in 47 per cent of the schools. (25 per cent did not know.)

3. A petty cash fund with which to purchase minor items of science equipment was provided for use by 27 per cent of the schools.

4. About one-half of the teachers personally spent money to buy some necessary science equipment. The range was from two to twenty-five dollars per year.

5. Homogeneous groupings for science classes were being used in one-fourth of the schools. The teachers, however, favored this type of grouping, if practical, by a nine to one margin.

6. Science career information was found in most of the science rooms. Only 30 per cent of these schools held a science career day. These were often held in conjunction with the school career day.

7. Science related assemblies were held by 62 per cent of the schools.

8. Fifty-eight per cent of the schools had participated in science fairs.

9. Science related clubs were organized in 38 per cent of the schools.

10. The gifted science-student programs varied throughout the state. Approximately one-half of the schools had an effectively organized program.

In order the most frequently used types of programs for the gifted students were: (1) special assignments, (2) informal teacher conferences, (3) assigned research projects to complete, (4) advanced classes, (5) work as special laboratory assistants, (6) special laboratory periods, (7) differentiated assignments and special classroom privileges, (8) special seminars, and (9) individual awards for achievement. One school reported allowing gifted ninth graders to elect biology rather than general science.

11. Twenty-seven per cent of the teachers belonged to scientific professional organizations. Nineteen per cent of this number belonged to the NSTA.

Methods and procedures. 1. Seventy-eight per cent of the teachers used the brief outline form of lesson plan. Seven per cent used a brief paragraph, 13 per cent had detailed outlines, while 12 per cent had no lesson plan.

2. Forty-seven per cent did not use the state course of study. This was probably due to its outdatedness, being published in 1932.

3. The type of development of the science programs in order of frequency of use was: (1) textbook as guide (89 per cent), (2) unit plan (52 per cent), and (3) resource unit (22 per cent). It was found that several used more than one type of development for some phase of instruction, thus the total of the above is more than 100 per cent.

4. Teachers had their upper class students give talks or demonstrations in science to pupils in junior high or grade schools in only 6 per cent of the schools.

[1] Donald C. Orlich. "An Appraisal of the Methods of Teaching Science in the Senior High Schools of Montana." Unpublished Master's Thesis, University of Utah, Salt Lake City. 1959.

5. Field trips were used by three-quarters of the science teachers. The range was from one to eight per year.

6. Lectures were used by all science teachers who took part in this study. Sixteen per cent specified that the lectures were held in conjunction with class discussions.

7. Demonstrations were used by all but 5 per cent of the science teachers. Of the total, 68.2 per cent made a demonstration daily or weekly. Pupil demonstrations were utilized by 79 per cent of the teachers.

8. All teachers taking part in the survey specified that a science textbook was being used on this question, 20 per cent of the teachers were dissatisfied with their texts. A trend seemed to indicate that more than one basic textbook was being used by over one-third of the teachers.

9. Workbooks were employed by 40 per cent of the teachers.

10. Supplementary science materials varied greatly. The items used most often were: (1) free and inexpensive materials, (2) encyclopedias, (3) science articles in the newspapers, (4) *Life* Magazine science articles, and (5) TV science programs.

Those materials used least often were: (1) the biographies and studies of the great scientists, and (2) check lists of inexpensive books for students.

11. *Current Science and Aviation* was the most popular periodical subscribed to by all pupils of a class. This accounted for one-third of the teachers.

12. The use of laboratory periods in biology, physics, and chemistry was widespread. In general science, 41 per cent of the schools *did not* offer a laboratory period.

13. Class projects were used in a minority by 50.5 per cent of the teachers. The practice of allowing the class to decide on a project and then to develop it under the teacher's guidance was utilized to a very minor extent by one-third of the science teachers.

14. Individual oral or written reports were used by 81 per cent of the teachers.

Student committees to gather and exchange information were used to a minor degree by one-third of the teachers. Paralleling this was the use of "buzz" sessions.

Audio-visual aids. 1. The chief sources of audio-visual aids for the science teachers were: the Montana State Film Library, private industry, federal governmental agencies, and the local school district film library.

2. Visual aids seemed to be used only to a minor extent by the Montana high school science teachers. This was partly explained by the fact that much of the equipment was unavailable to the teachers. The most common types, in order of use were: (1) wall charts, (2) display cases, (3) films, (4) film strips, (5) slides, and (6) the micro projector. Those least commonly used were: (1) overhead projectors, (2) opaque projectors, and (3) tape recorders. Bulletin boards, posters, and displays were used by about one-half of the teachers.

Library and facilities. 1. All schools taking part in the study subscribed to at least one science periodical. The range was from one to thirteen. The three most frequently subscribed magazines were: *Popular Mechanics*, *National Geographic*, and *Science Digest*.

2. All high school libraries had science related books. The median

number of such books in a given school ranged from twenty-one to fifty.

Testing and evaluation. 1. Major tests were given mostly at the end of each unit. Minor tests were usually given weekly.

2. The teacher-constructed test was the most often used type of test and included the following items: (1) completion, (2) problem solving, (3) multiple choice, (4) matching, and (5) essay. The items least used were: (1) performance, (2) attitude scales, (3) multiple response, and (4) true and false. Only 11 per cent of all the science teachers used standardized tests rather frequently.

3. The methods used in determining students' grades followed this order: (1) results from teacher-constructed tests, (2) assignments, (3) effort, and (4) participation. However, the following were also considered of major importance by as many as 25 per cent of the teachers: (1) attitude, (2) student ability, (3) laboratory write-ups, (4) projects, and (5) oral or written reports.

Opinionnaire. Included in the questionnaire was an opinionnaire of some current trends. The following were the reported results.

The Montana science teachers disagreed with: (1) allowing students to plan the course with the teacher acting as the guide, and (2) using more teacher demonstrations and fewer pupil experiments.

The trends with which they agreed were: (1) offering laboratory for all science courses in the program; (2) introducing more science courses for "better" pupils; (3) offering physics and chemistry in two sections where possible, one for college preparation, the other for noncollege preparation; (4) equipping the school with science equipment that could be used for all science courses rather than for specialized courses where possible; (5) allowing "better" students to take biology as ninth graders rather than taking general science; (6) using more experiments and less audio-visual aids; and (7) covering fewer topics more thoroughly, rather than covering several topics less thoroughly.

Suggested criteria for making improvements in science teaching were ranked by Montana teachers as follows: (1) have more useful laboratory equipment, (2) have better physical facilities, (3) attend summer sessions for increased science knowledge, (4) have smaller classes, (5) have fewer classes per day, and (6) have better library facilities.

Conclusions. Largely, the methods used were adequate enough to provide a functional science experience. Incorporation of some newly developed methods adapted to the circumstances of the individual teachers could probably help to improve the science instruction. In general, more traditional methods were most frequently used by the Montana science teachers.

The science teachers polled in this survey were adequately prepared. Only 2 per cent were inadequately prepared to teach science. One high point was the fact that two-thirds of the science teachers were teaching science and mathematics as academic subjects.

Too few science teachers were aware of the benefits that could be derived by belonging to a scientific professional organization.

This study could be of value to science teachers as a check list of their own methods of teaching.

NSTA Activities

European Tour, 1960

Itinerary and full information have been mailed to Life and Sustaining members (in December). The mailing also included application blanks for the tour which will be limited to thirty participants. Additional requests for forms should be sent to NSTA headquarters.

Arrangements for the tour involve considerable correspondence and effort in coordinating our plans to meet within the time limits of our trip with leaders in science teaching, teacher education, Ministers of Education, and related groups in other countries. Early confirmations are needed on conference dates, locations, agenda, and participants in order to assure that teachers and professional personnel of other countries will be able to meet with us for a mutual exchange of ideas. Coupled with these international meetings will be visitations to schools and universities, special scientific installations, historical science facilities, and related tours.

As now planned, the itinerary includes stops in London, Amsterdam, Bonn, Heidelberg, Munich, Salzburg, Geneva, and Paris. No major deviations from the tour schedule will be permitted. If feasible, however, occasional side trips not exceeding one-day duration may be arranged. Tour members who may wish to extend their stay in Europe beyond the terminal date may make private arrangements to do so.

Departure date is July 19, 1960, from Idlewild Airport, New York City, with return arrival to New York from Paris, France, on August 27, 1960.

NSTA Staff Changes

New Director

Appointed recently as Director of Youth Activities under NSTA's FSAF program is William P. Ladson of Alexandria, Virginia. In this new position, Mr. Ladson will be working directly with NSTA's Standing Committee on science education activities for youth, the FSAF Administrative Committee, and NSTA's representatives on the editorial board of the *Science World* student publication. The development of a program for Future Scientists of America youth activities, services, and organization is a new NSTA goal and is now to take shape. As reported to you in the December 1959 *TST* issue, your comments and recommendations for administration of this program are invited.

Mr. Ladson

The new Director of these activities, Mr. Ladson, was formerly Head of the Science Department and chemistry teacher at Fairfax County Groveton High School, Fairfax, Virginia. Born in 1929 in Washington, D. C., Mr. Ladson now resides, with his wife, Claire R., and their four-year-old son in Alexandria, Virginia. He graduated from Mount Vernon High School in Alexandria in 1946, completed his BS Degree in Chemistry in 1953, and his Master's Degree in Education and Administration at the University of Virginia, Charlottesville, in 1958. His teaching experience of six years began at Waynesboro High School, Virginia, in 1953. His activities comprise association with a number of educational associations, including the Fairfax County Federation of PTA, the Virginia Education Association, and Phi Delta Kappa. During the past year, he was selected as the typical teacher and featured in the Fairfax County Board's annual report. His experience covers a wide background in science clubs, science fairs, summer programs for youth, summer institutes coordinator, and related public relations work in education.

Publications Staff

Under the Publications Section responsible for production of *The Science Teacher* and other NSTA publications and advertising are two newly assigned staff assistants. Mrs. Jacquelyn A. Fish, a newcomer, joined the staff in October when she came to Washington to live permanently in her new role as wife of Paul W. Fish of the Defense Department. A native of Illinois, she served formerly as Advertising Manager with J. B. Lippincott Company in Chicago. She attended Trinity College in Washington, D. C., and received an AB Degree in History-Government. Her new position will entail editorial work on publications, newsletters, press releases, production, and related public relations functions.

Miss S. Justine Burton, who joined the staff last year as Editorial Secretary, has been promoted to assume other editorial reponsibilities and work on publications. This will be in addition to her secretarial duties. Her former experience covers a range of art, administration, and editorial activities. Her past experience includes two years in this capacity in another NEA Department and six years with the American Red Cross. Miss Burton was born in Puerto Rico, came to New York as a child, and has since lived in Washington, D. C.

White House Conference

The Golden Anniversary White House Conference on Children and Youth is to be held March 27-April 21, 1960 in Washington, D. C. The purpose of the conference is "to promote opportunities for children and youth to realize their full potential for a creative life in freedom and dignity." The first of these conferences was called by Theodore Roosevelt in 1909. They have been held every ten years since then.

Conference participants will include representatives of state committees and national organizations, 700 young people, national leaders, and 500 international guests. NSTA's representatives are Sydney Blum, Science Specialist, Baltimore City Schools, Maryland, and Robert H. Horn, of the faculty of Waynesboro High School, Waynesboro, Virginia.

"Dimensions in Living"

The Dow Chemical Company, the Hecht Company of Washington, D. C., and the NSTA are sponsoring an experimental program to better acquaint the public with their schools. This program, scheduled April 20-30, will consist of exhibits in science, home economics, and industrial arts. The exhibits will be shown in the four Hecht Company stores in the metropolitan Washington area.

Public schools and parochial schools in the area have been invited to participate in the program. Displays at each store will be prepared by the area schools.

Convention NOTES

K-12 at Kansas City

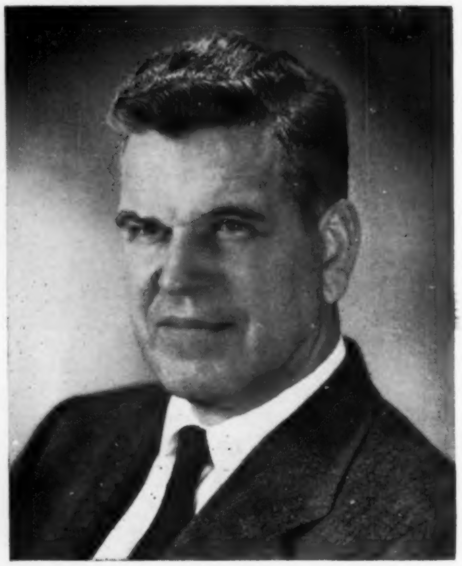
As President Donald G. Decker raises his gavel for the count-down to begin the convention proceedings, the cloud of expectancy and anxiety inherent in long months of planning will burst into a shower of prolific and challenging events. In the words of Lawrence Appley: "A profession is an activity requiring extensive and intensive preparation for the rendering of a highly specialized service."

In the theme of our convention, "Current Science and the K-12 Program," we have established the goal for a highly specialized service. In the person of our members, participating speakers, and guests, the convention has been planned to bring

Pictorial Graph of the American Public School System. Ernest Horn Elementary School, Junior High School, and Senior High School of Colorado State College, Greeley. Left to right: Bobetta Holmes, twelfth grade; Keith Shaw, eleventh grade; Jane Holley, tenth grade; Jim Stamper, ninth grade; Karel King, eighth grade; Gary Meyer, seventh grade; Lou Ellen Kay, sixth grade; Jim Hartmen, fifth grade; Barbara Greer, fourth grade; Dick Quammen, third grade; Karen Chaloupka, second grade; Lee Morrison, first grade; and Sharie Kennedy, kindergarten. Photo by Robert Waters, Colorado State College, Greeley.

WALTER H. BRATTAIN. Physical Research Department, Bell Telephone Laboratories, Murray Hill, New Jersey. Co-winner of the 1956 Nobel Prize in Physics for his investigations in semiconductors and the discovery of the transistor effect. Speaker, Business-Industry-Education luncheon, Thursday. Subject: "The Essence of Science and Science Teaching —a Personal View."

LINUS C. PAULING. Professor of Biochemistry, California Institute of Technology, Pasadena. Recipient of 1954 Nobel Prize in Chemistry for his research on the chemical bond and its application to structure of complex substances. Frontiers of Science series. Speaker, Second General Session, Wednesday evening. Subject: "High-Energy Radiation and Its Effects on Man."



JOHN R. HELLER. Director, U. S. National Cancer Institute, Bethesda, Maryland. Frontiers of Science series. Speaker, Fourth General Session, Thursday evening. Title: "Progress In Cancer Research."

Kansas City, Missouri

DONALD G. DECKER. NSTA President and Dean of the College, Colorado State College, Greeley. Presiding officer and speaker, First General Session, Wednesday afternoon. Subject: "The Ecology of the Educational Community."

you a lifting of sights and a restoration of self-confidence for leadership in meeting our professional responsibilities.

The notable speakers appearing on these pages will be featured in General Sessions throughout the week. Planned to bring you recent developments in major fields of science, these addresses alone and those under the "Frontiers of Science" series are worth your convention ticket.

Early in January, convention brochures were mailed to all NSTA members and participants in which considerable information was outlined about the program of sessions and events. Advance registration and reservation forms were included for the tours, the workshops, meal functions, and hotel accommodations. *Everyone planning to attend the convention and who is able to register in advance is urged to do so promptly.* Include with your advance registration as many reservations for other events as you can at an early date. Letters and requests are

GEORGE B. KISTIAKOWSKY. Science Advisor to the President of the United States. Speaker, Annual Banquet, Friday evening. Frontiers of Science series. Topic: "Science and Citizenship."

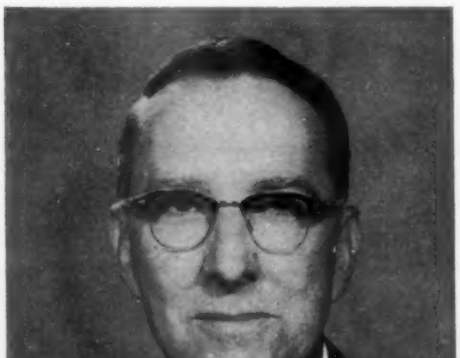
being received from members, as well as other interested persons, from all over the country this year asking about the convention program, scheduled events, and exhibits. One record for NSTA has already been established in that 100 commercial exhibit booths have been reserved. This is an increase over our previous high of 78 established at the 1959 convention in Atlantic City.

This year, arrangements have also been made to have open discussion periods with the STAR '60 award winners. The winners in the STAR '60 program will be introduced during the Thursday evening General Session on March 31. Selected on the basis of entries which demonstrate effective science teaching methods, winners will be available at the convention as consultants to answer questions or exchange views with other

March 29-April 2, 1960

LEONA M. SUNDQUIST. Chairman, Department of Science, Western Washington College of Education, Bellingham, Washington. Speaker, Fifth General Session, Friday morning. Subject: "Teacher Education for the K-12 Program in Science."

ROBERT H. JOHNSON. Superintendent of Jefferson County Public Schools, Lakewood, Colorado. Speaker, Third General Session, Thursday morning. Subject: "How a K-12 Program Develops."



JOE ZAFFORONI. Professor of Science Education, University of Nebraska, Lincoln. Address at elementary science luncheon, Friday. Title: "The Case of Mrs. Doe."

JOHN H. FISCHER. Dean, Teachers College, Columbia University, New York City. Featured speaker, Sixth General Session, Saturday morning. Topic: "K-12 in Relation to the Total School Program."

NSTA KANSAS CITY COMMITTEE

ANDERSON PHOTO COMPANY

(Seated) Miss Lucille Berlin, Tulsa Public Schools, Tulsa, Oklahoma; Mrs. Mildred Ballou,* Station KDPS-TV, Public Schools, Des Moines, Iowa; Sister Anna Joseph, Redemptorist-Nazareth Academy, Kansas City, Missouri; Miss Dorothy Tryon,* Redford High School, Detroit, Michigan; Mrs. Edith Link, Jefferson City Senior High School, Jefferson City, Missouri; Miss Marilyn Suthard, NSTA, Washington, D. C., secretary to the committee. (Standing) Dr. John W. Bruekelman, Kansas State Teachers College, Emporia; Mr. J. Donald Henderson, University of North Dakota, Grand Forks; Mr. Otis W. Allen, Leflore County Schools, Greenwood, Mississippi; Mr. Dewey Miner, Kansas City Public Schools, Kansas City, Missouri; Dr. Donald G. Decker, Colorado State College, Greeley; Dr. Robert C. Sherman, North Texas State College, Denton; Mr. Robert H. Carleton, ex officio, Executive Secretary, NSTA, Washington, D. C. (* Co-chairmen of the Committee.)

members on their projects. In addition, they will be active participants in some of the "Here's How I Do It" sessions scheduled on Saturday afternoon, April 2.

As pointed out earlier, we will have members of the newly formed NSTA Section for Supervisors, Consultants, and Coordinators at the convention, and meetings for an exchange of views have been planned. In addition, the Association for the Education of Teachers in Science will meet in conjunction with NSTA to evaluate professional goals and direction.

The Kansas City Committee of NSTA has had excellent cooperation and interest from the KC local committees in providing for your needs and comfort. We do not believe that anything has been overlooked and challenge you to accept our invitation for a worthwhile venture.

The Convention Proceedings will again be prepared by Hugh Allen, Jr., Montclair State College, New Jersey, who did such an excellent report on the 1959 Convention. Pre-publication orders will be taken for the 1960 Convention Proceedings at Kansas City at the NSTA Exhibits booth.

Don't miss this year; consult your brochure and send in your reservations now!

Classroom IDEAS

Chemistry

The Role of Calcium in the Coagulation of Blood and Milk

By EDWARD FRANKEL, The Bronx High School of Science, New York City

The coagulation of blood and the curdling of milk do not appear to have much in common. Nevertheless, these two seemingly unrelated processes are very similar in their chemical and physical features. Both reactions are mediated by specific enzymes which irreversibly convert a soluble protein into an insoluble coagulum. Calcium ions must be present for coagulation to occur and the coagulum which forms contracts, squeezing out a clear fluid, serum in blood and whey in milk.

A stimulating series of demonstrations and/or laboratory exercises may be performed centering around the effects of calcium ions on the coagulation phenomena. The basic principle involved in these experiments is demonstrated by the fact that when calcium ions are removed from milk and blood, coagulation is suppressed; when calcium ions are restored, coagulation is thereby induced.

The Effects of Calcium on Blood Coagulation. One of the technical difficulties encountered in attempting to use blood for experimentation or demonstration is the fact that freshly drawn blood coagulates within a few minutes. It is standard procedure to prevent the clotting of blood by adding an anticoagulant such as citrates or oxalates which replace the calcium ions. A supply of citrated or oxalated blood is readily obtained from a local hospital, usually outdated blood-bank blood. To restore its clotting properties, add a few drops of 1 per cent calcium chloride solution and within a few minutes the blood will gel forming a solid mass. In time, the clot will retract (shrink) and a straw-colored liquid, serum, will appear.

The Effects of Calcium on the Coagulation of Milk. The following experiment may be used to demonstrate the similarity of the coagulation process in milk with that in blood.

1. Fill three test tubes with milk and place them in a water bath (37°C).
2. To tube No. 1, add a pinch of rennin (rennet).
3. To tube No. 2, add a pinch of rennin and a pinch of an anticoagulant, such as sodium citrate or sodium, potassium, lithium or ammonium oxalate, or fluoride.
4. To tube No. 3, add nothing; it serves as a control.

Within a few minutes, the milk in tube No. 1 solidifies into a jelly-like mass which remains in the tube when it is inverted. The contents of tubes No. 2 and No. 3 remain unchanged.

5. Add a few drops of 1 per cent calcium chloride solution to tube No. 2. In a few minutes it coagulates.

The coagulation of milk by rennin involves the conversion of the milk protein caseinogen to paracasein. When the paracasein combines with the calcium, an insoluble compound, calcium paracasein, forms. Upon standing, the coagulum contracts and a clear whey forms. By adding calcium chloride to milk containing the anticoagulant which has removed the calcium, coagulation is made possible.

Chemistry

Detergent Comparisons

By H. JESS BROWN, East High School, Salt Lake City, Utah

Purpose: To show how different types of detergents and soaps react with different types of water.

This demonstration, to my knowledge, has not appeared in the literature. It is interesting and revealing to elementary, junior high, or senior high and adult groups alike. Try it and I believe it will become your favorite.

Materials: Six cylinders (1½ inches in diameter or larger), or six bottles, beakers, etc.; two medicine droppers (or pipettes); small bottle of *non-soap* shampoo (Prell or Drene, for example); small bottle of *soap* shampoo (such as Lan-Lay Eucalyptus shampoo); a suitable quantity (a quart or two) of (a) distilled water or de-ionized water, (b) water that has been through a home-type water softener, and (c) tap water; six one-half inch pieces of wool yarn.

Procedure: Label the six cylinders A, B, C, D, E, and F. Half fill A and B with distilled water, C and D with water softener softened water, and E and F with soap water.

Drop 1 cc (or a half-dozen drops or medicine dropper half-full) of the *soap* detergent into cylinders A, C, E. Using the other medicine dropper, drop an equal amount of the *soapless* detergent into cylinders B, D, and F.

Stir or rotate the cylinders briefly to hasten dissolution but avoid creating any foam on the top as it would interfere with the latter part of the experiment.

Now stand back and observe that cylinders A, C, and E have clouded up. (A, very slightly or not at all; C, a little more than A; and E, considerably.) Also observe that cylinders B, D, and F have remained unchanged.

Here you might wish to point out that the soap (principally soluble sodium stearate) has reacted with the differing amounts of Ca, Mg, or Fe ions in A, C, and E, forming varying amounts of insoluble soaps thus rendering the soap useless in E as a cleaning agent, or affecting it slightly or not at all in C and A.

It is also apparent that the *soapless* detergent in B, D, and F has been to no visible extent removed by precipitation.

One extremely important feature of a cleaning agent is its effect upon the surface tension of its solvent (usually

water). The surface tension is inversely proportional to its penetrating (thus cleaning) properties. If the water cannot penetrate, it cannot clean.

The effect of the detergents upon the surface tension of the tap water may now be demonstrated by dropping simultaneously a ½-inch piece of wool yarn upon the liquid surfaces of E and F. The rate at which the yarn submerges (becomes wet) is a rough measure of the effect of the detergents upon the surface tension, thus its cleaning properties. (Care should be taken here that the pieces of yarn are in approximately the same physical condition. If one is fluffed up or they are both fluffed up, but unequally, the difference between penetration rates would not be due entirely to surface tension differences, but would be partially due to the state of compactness of the yarn. The results of the demonstration might not be satisfactory.)

Subsequent addition of pieces of yarn to cylinders C, D, A, and B illustrates that the difference in the cleaning properties between the *soap* and *soapless* detergents becomes less as the water becomes more soft. (Soft water contains fewer Ca, Mg, etc., ions.)

The teacher may or may not wish to mention that the soapless detergents' advantage in hard water stems from their apparent unconcern for the presence or absence of ions which make water "hard." The soap reacts with these particles and must remove them all before it can go to work. The *soapless* detergents ignore these particles and go right to work equally as well in "hard" as in "soft" water.

Also of concern to some people is that the precipitate which forms when soap reacts with hard water ingredients has a tendency to form a type of film on washed substances.

Finally, one of the best things about this demonstration is the large number of variations possible with it. Instead of the water softener softened water (or in addition to it, if you wish, in cylinders G and H), you might wish to soften the water on the spot with a commercial chemical water softener such as TSP (trisodium phosphate), Borax (sodium tetraborate), or washing soda (sodium carbonate), and accompany the demonstration with appropriate remarks on how these substances render the water "soft." Also, you could deliberately vary the degree to which the yarn is packed or fluffed up and take particular note of how this affects the rate of wetting the yarn.

Many other variations have or will occur to the thoughtful teacher which will make this experiment better suit his needs or groups.

Total time for demonstrations and remarks varies from no less than ten minutes to upwards of an hour depending upon the thoroughness with which the teacher explains the experiment.

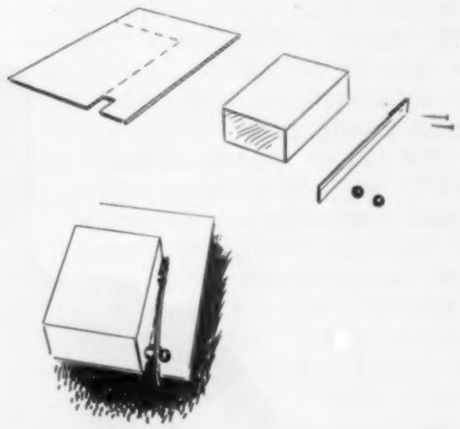
Physics

Second Law of Motion Apparatus

By RICHARD F. THAW, Department of Science Education, San Jose State College, San Jose, California

An idea borrowed from Beauchamp, Mayfield, and West[1] has proved to be very successful in demonstrating Newton's Second Law of Motion. The device illustrated is easily constructed in a matter of minutes. The materials consist of single strength plywood, a block of wood two inches thick, a common ruler, and two marbles. In order to achieve proper tension with the ruler, small shims can be inserted at the end of the ruler where nailed to the block.

As shown in the drawing, one marble is held above an opening by the ruler. The second marble rests on a narrow platform on the outside of the ruler. The general principle of the apparatus is that the marbles are arranged so that by sharply snapping the free end of the ruler, the support is taken from one marble and it is allowed to fall straight down to the floor. At the same time the other marble is given a very sharp blow



PREPARED BY A-V SERVICE, DEPARTMENT OF EDUCATION SAN DIEGO COUNTY

to move it horizontally—just as a bullet is projected from a gun. When the marble is started horizontally, there is no longer any support for it and it falls to the floor, but not directly underneath the spot where it was held at rest.

The important thing to observe is that both marbles reach the floor at the same instant (determine this by listening), indicating that the horizontal motion given to the marble and the vertically downward motion produced by gravity have acted entirely independently of each other. The motion from the horizontal level to the level of the floor is due only to gravity. The weight of any object, or the force which it exerts, is directly proportional to the object's mass and the acceleration due to gravity.

[1] *Everyday Problems in Science*. Scott, Foresman and Company, Chicago, Ill. 1957.

FSA Activities

SAAS, 1960

CALL FOR FINAL ENTRIES. Science teachers all over the U.S., Canada, and in American military schools in foreign lands have requested nearly 27,000 sets of student entry materials for the 1960 Science Achievement Awards for Students program! The students, from grades seven through twelve, are now busy with investigative types of projects for which they will write reports to be submitted through their teachers for judging in the SAAS competition. Have you sent in your request yet? Your students' entries must be postmarked by *March 15, 1960.*

Remember, there are Future Scientists of America pins for the winners and plaques for their schools as well as other student awards of U. S. savings bonds. Most important, however, is the invaluable experience your students will gain in doing their research projects. (See Cover II for information.)

We remind you also of the publications awards announced in the November issue of *TST*. Scholastic Magazines, Inc., publishers of the student publication, *Science World,* will give to all 220 regional and national winners a free one-year subscription to *Science World.* This publication, which now includes the section *Tomorrow's Scientists* (NSTA's former publication) is one every student will want to receive. It includes the latest exciting science events and technology happening in every major field or scientific area. Current biographies, projects, and experiments conducted by both scientists and students can stimulate other science projects. Each school year there are sixteen issues for you to use as reference and help in your school projects.

Secondly, *Science Digest* will award one-year subscriptions to the 22 winners of national awards for projects that relate to metals or metallurgy. With the world of fast-moving events in science, students have an obligation to keep up and read with science.

Roster of Sponsors

Since the listing in September 1959, the following sponsors of FSAF activities have contributed their support through financial assistance and cooperation. Through January 7, 1960, these contributions from our business-industry organizations total $7,850.00.

R. P. Dinsmore
E. I. du Pont de Nemours & Company
The Fluor Corporation, Ltd.
Gulf Oil Corporation
The Johnson's Wax Fund
The Library of Science
Mallory-Sharon Metals Corporation
The Martin Company
National Cash Register Company
Owens-Illinois Glass Company
The Pfizer Foundation, Inc.
Philco Corporation
The Pittsburgh Plate Glass Foundation
Radio Corporation of America
Revlon Foundation, Inc.
Science Research Associates
Signal Oil and Gas Company
Spencer Chemical Company
United Aircraft Corporation
Vanadium-Alloys Steel Company
Victor Chemical Works
Warner-Lambert Research Institute
Western Electric Company
West Virginia Pulp and Paper Company

U. S. Registry

The U. S. Registry containing the names of more than 150,000 teachers of junior and senior high school science, mathematics, and modern foreign languages is completed and now ready for distribution by NSTA.

The purpose of the Registry is to facilitate the mailing of current professional information and materials to teachers of science, mathematics, and languages. Additional information will be available in the next issue regarding the present compilation. Orders or requests on the Registry should be sent directly to NSTA.

AETS TO MEET IN KANSAS CITY

The second annual concurrent meeting of the Association for the Education of Teachers in Science (AETS) and the National Science Teachers Association will be held in Kansas City on March 29 and 30, 1960. During the year 1960-61, AETS will develop a policy statement on the preparation of science teachers. Many groups have made recommendations on this topic. This year's annual meeting of AETS will be devoted to a preliminary study of the questions and problems involved in such a policy statement, and the theme is "Current Concerns and Issues in Science Education." Dr. J. Stanley Marshall of the Florida State University will give a keynote address, "The Science Teacher for American Schools and How He Should Be Educated." Three other formal papers will also be presented. Dr. Ellsworth Obourn of the U. S. Office of Education will speak on "Liberal Arts and General Education Science Programs for American Teachers"; Dr. Joseph J. Schwab of the University of Chicago and of the newly formed Teacher Education Committee of the AIBS[1] will present "The Professional Education of Science Teachers"; and finally, Dr. Hubert Evans of Teachers College, Columbia University, will speak on "New Patterns for the Education of Science Teachers."

Members are asked to come prepared to make this an effective working conference. If AETS is to develop a policy statement for science teacher education which is representative of science educators throughout the nation, helpful ideas will be needed. Preparation for the conference should include study of the reports of the President's Commission, the AAAS[2] (Garrett) report, and the 1958 and 1959 TEPS[3] Conference reports. It would be helpful to bring, in writing, your own recommendations related to future policy and program.

HAROLD E. TANNENBAUM
President
Association for the Education of Teachers in Science

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[1] American Institute of Biological Sciences.
[2] American Association for the Advancement of Science.
[3] Teacher Education and Professional Standards.

N·S·T·A LIFE MEMBERS

On January 15, 1960, the membership count showed a grand total of 14,800. This is an increase of over 2000 members in 1959. Part of this growth took place in our roll of life members which now totals 480. Of this number, 71 have been added since the last listing of new life members in the February 1959 issue of *TST*.

We welcome these new members and their enthusiastic support of NSTA activities.

Life membership in NSTA is $175 if paid in 10 annual installments, or $150 if paid in three years or less.

Allen, C. Sumner, Buzzards Bay, Massachusetts
Anderson, Robert G., Albert Lea, Minnesota
Bach, Lawrence E., Ithaca, New York
Ballou, Mildred, Des Moines, Iowa
Bartow, Virginia, Urbana, Illinois
Belisle, Joseph A., Montclair, New Jersey
Berryman, Dorothy, River Edge, New Jersey
Boatwright, Virgil E., Kansas City, Kansas
Branam, Ernest, Jr., Hobbs, New Mexico
Brown, Willis, Jr., Woodbine, Georgia
Carin, Arthur, Flushing, New York
Carr, Albert, Honolulu, Hawaii
Castellani, George J., Floral Park, New York
Chase, John B., Jr., Chapel Hill, North Carolina
Cheatham, Iverson W., Hayti, Missouri
Cottone, Mary A., Ludlowville, New York
Coy, Kenneth W., Wichita, Kansas
Davis, Gordon W., Big Rapids, Michigan
Day, William W., Green River, Wyoming
Decker, Donald G., Greeley, Colorado
Dobosh, Emery, Tucson, Arizona
Dunn, Waldo E., Willimantic, Connecticut
Eklund, Carl L., Floral Park, New York
Fitzgerald, Ruby, Shreveport, Louisiana
Gagnon, Frederick G., Moodus, Connecticut
Geertson, Lyle R., San Bernardino, California
Ghang, Darwin, Rivera, California
Gilliland, O. Boyd, Austin, Texas
Hardwick, T. Barton, Jr., Anderson, California
Hardy, Charles, Olympia, Washington
Hines, Sallylee, Fayetteville, Arkansas
Hugar, Calvin, Driftwood, Pennsylvania
Hyde, Clarence A., Clinton, Missouri
Jones, Haskell, Arkadelphia, Arkansas
Kacena, W. J., Jr., Des Moines, Iowa
Kaskel, Marcia, Lawrence, L. I., New York
Killinger, George, Jr., Bettendorf, Iowa
Kirchhofer, Don W., Jacksonville, Illinois
Kochanowski, H. J., Aliquippa, Pennsylvania
Linde, Carl A., Jr., Seattle, Washington
Lovelace, Allen J., Roswell, New Mexico
Lowry, Edward G., Sidney, Ohio
Maben, Jerrold William, East Lansing, Michigan
Marshall, George C., Jr., San Jose, California
McCollum, Howard Pierce, Baton Rouge, Louisiana
McDermitt, Carrol, Oklahoma City, Oklahoma
McElfresh, Eloise, Charleston, West Virginia
Mepham, Stuart G., Garden Grove, California
Mikelson, Sylvan L., Dearborn, Michigan
Minken, Patricia, Buffalo, New York
Mosteller, Robert H., Glendale, Ohio
Okano, Robert J., Seattle, Washington
Palmer, William F., Thomasville, North Carolina
Patterson, Herman M., New York, New York
Peebles, James B., Rock Island, Texas
Pell, Edwin Albert, Jr., Scarsdale, New York
Phillips, William M., Minturn, Colorado
Pickering, Ramona C., Colorado Springs, Colorado
Poppleton, Phillip A., Enumclaw, Washington
Potter, Donald G., Reno, Nevada
Rassam, Edmond A., Chicago, Illinois
Renner, John W., Washington, D. C.
Rollins, Jerrett W., Belmont, California
Sentman, Richard J., Tonawanda, New York
Snider, John H., Jr., Urbana, Ohio
Sparrow, D. E., Columbus, Ohio
Tracy, Helen G., Crescent City, California
Varella, M. David, North Easton, Massachusetts
Webster, Vera R., Munster, Indiana
Will, Emery L., Oneonta, New York
Yamamoto, Thomas I., Honolulu, Hawaii

NSTA CALENDAR

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST's* calendar editor as early as possible.

February 10-13, 1960: 33rd Annual Meeting, National Association for Research in Science Teaching, Chicago, Illinois

March 29-April 2, 1960: NSTA Eighth National Convention, Muehlebach and Phillips Hotels, Kansas City, Missouri

June 29, 1960: NSTA Annual Summer Meeting with National Education Association, Los Angeles, California; Luncheon meeting and afternoon session

June 29-July 1, 1960: Annual Business Meeting of Board of Directors, Los Angeles, California

September 9-10, 1960: NSTA Regional Conference, University of North Carolina, Chapel Hill

October 28-30, 1960: NSTA Regional Conference, Deauville Hotel, Miami Beach, Florida

AO Reports on Teaching with the Microscope

The ABC's of Blood Typing...or for every agglutinogen there's an agglutinin.

Using the internationally accepted Landsteiner classification system, human blood can be classified into one of four types; A, B, AB or O, according to the presence and type of agglutinogen in the red blood cells. Agglutinogen A = type A; agglutinogen B = type B; agglutinogens A and B = type AB; no agglutinogens in red blood cells = type O. In addition, there is an agglutinin factor in the serum of each individual which is, necessarily, compatible to his agglutinogen factor:

Agglutinogen	Blood Type	Agglutinin
A	A	Anti B
B	B	Anti A
A and B	AB	None
None	O	Anti A and Anti B

Blood can be typed by mixing unknown whole Blood (or red blood cells in suspension) with agglutinins (anti sera) of known factors. If the two are incompatible, agglutination, or clumping of red cells will occur.

There are many clinical tests for blood typing...some very complicated and some relatively simple.

The experiment below by Dr. Frank E. Wolf is simple enough for the classroom but accurate, and will serve to acquaint the student with the basic clinical laboratory methods used in blood typing and cross checking preparatory to making blood transfusions. Also, much to our delight, it emphasizes the important role the microscope plays in the clinical laboratory.

Using the AO 66 Microscope the student also gains the added experience of working with a low-cost model of the more expensive laboratory scopes...featuring the same high-quality optics plus coarse and fine focusing adjustments. If you have not already done so ...why not let us show you how little it costs to equip your classes with this exceptionally fine instrument. Write American Optical Company, Instrument Division, Dept. B95, Buffalo 15, New York.

EXPERIMENT

Determining Individual Blood Types.

By: Dr. Frank E. Wolf
Professor of Biology
State Teachers College
Fitchburgh, Mass.

MATERIALS AND PREPARATION:

Blood lancet or scalpel blade (obtained from any biological supply house) inserted into a cork stopper; glass slides; wax marking crayon; anti A and anti B typing sera (obtainable from medical supply house); wooden applicator sticks or toothpicks; absorbent cotton; flask of 70% alcohol; AO Spencer #66 compound microscope.

Fig. 1

PROCEDURE:

1. Prepare slide (Fig. 2).
   a. Draw vertical line near mid-point with wax marking crayon.
   b. Mark A in upper left corner, and B in upper right.

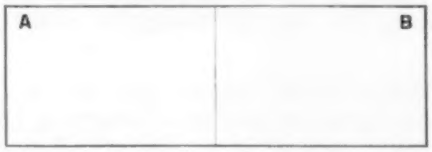


Fig. 2

2. Prepare to draw blood.
   a. Scrub finger with alcohol and cotton sponge.
   b. Wipe dry.
   c. Shake bottle of alcohol with lancet through cork, remove cork and make small puncture with lancet (Fig. 1).
   d. Wipe off first drop of blood with dry cotton.
   e. Place a *small* drop of blood on both sides of slide (Diagram 3).
   f. Place alcohol sponge over punctured finger.
3. Apply anti sera.
   a. Break an applicator stick in half.
   b. Place a small drop of anti A sera on the A side and a small drop of anti B sera on the B side, over the blood.
   c. Mix blood and sera on A side with one stick and *immediately discard;* repeat on B side with different stick.
4. Read.
   a. Tap slide with finger.
   b. Read under low power of microscope (Fig. 3) within 15-20 seconds.

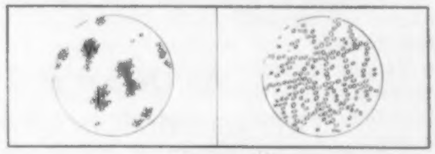
Fig. 3

PRECAUTIONS:

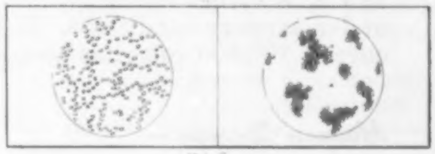
1. Mix each side of slide with a *different stick.*
2. Agitate by tapping slide to overcome rouleaux-formation or dilute serum with a salt solution.
3. Do not run drops of blood and sera into marking crayon; red wax may be mistaken for clumped cells.

INTERPRETATIONS:

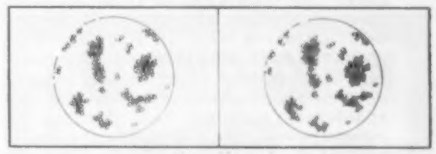
1. Determining blood types: Observe for agglutination on both sides of slide. Use illustrations below to help determine blood types.



Type A



Type B



Type AB

Type O

2. Importance of blood typing.

The prime purpose of blood grouping is to provide definite information necessary for immediate or future selection of a suitable donor for a blood transfusion. A cross-match of donors red blood cells with recipients serum and recipients red blood cells with donors serum should precede any transfusion to prevent the possibility of fatality. (More advanced classes can carry grouping a step further to include the Rh Factor).

BIOLOGY TEACHERS! $25 for your experiment. Our original offer was so well received and response so great that we were forced to discontinue it.

We're looking for more experiments now, so our offer is renewed. Send us your favorite experiment. If accepted for future ads like this one, we will promptly send you $25. In the event of similar experiments, the one bearing the earliest postmark will be considered. Write Dept. B95.

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Instrument Division • Buffalo 15, New York

BOOK Reviews

Nature and Man's Fate. Garrett Hardin. 375p. $6. Rinehart & Company, Inc., 232 Madison Ave., New York 16, N. Y. 1959.

It is extremely difficult for the biologist to realize that there are still people who regard the evolutionary process as a "theory," and genetics as the sort of thing best thought of in terms of bees and pollen. To break down this view, where it still remains, has always been the responsibility of the teacher. But before Hiroshima this responsibility did not have the terrible urgency that it has today. Dr. Hardin's excellent book explains clearly both the terror and the urgency.

Dr. Hardin writes crisply and, above all, interestingly. Unlike many expounders of science, he never becomes so fascinated by his companions on the stage that he forgets the audience. His companions are those who have written about evolution and genetics, particularly as it affects man in relation to himself. The first speaker is Darwin who, with Wallace, had the courage to say what had long been apparent—that animals and plants in all their variety were not a stagnant mass but a brilliant, ever-changing procession extending from a dimly known antiquity to an unknown future. The impact of these views on the Victorian Episcopal Church, and their descendants like William Jennings Bryan, is too well known to need repetition.

It is a little ironic that genetics runs foul of one tenet of our American faith. Let us continue to fight that all men may be born free. But we know now that they are not, and cannot be, born equal. For in each human sperm, and in each human egg, there is a vast assortment of genes which dictates what the child can become. No amount of environment will grow his hair black instead of red, or his eyes blue instead of brown. His environment will help to develop his genius —if he has it—but will not give it to him if it is not in his genes.

Fortunately, these truths are even more repulsive to the communists than they are to us. One of the most notable of all the Russian purges was that which cast out of laboratories—and in many cases out of life itself —all those scientists who had the courage to uphold the truth of evolution and genetics. An ill-educated party hack called Lysenko, who believed with Stalin that environment could change heredity, is now the official mouthpiece of Soviet "biology."

And in this there lies a very real danger. We know beyond all doubt that exposure to atomic—or any other—radiation can influence the heritable characters of man. We also know that almost all induced heritable changes are bad. Hence to increase radiation is to downgrade the race, an effect probably not noticeable in less than a dozen generations. We know this and we care. But the Russians are not allowed to know it, so why should they care? It is a grim example of the frightful consequences that can come from suppression of truth.

This is a book to be read by all who have the courage to face the truth—that man is an imperfect animal who spends more of his energies in seeking self-destruction than in seeking self-improvement. This unpleasant fact has been pointed out from the time of the Greek philosophers. The Atomic Age is probably our last chance to do something about it.

PETER GRAY
University of Pittsburgh
Pittsburgh, Pennsylvania

Mathematics and the Physical World. Morris Kline. 482p. $6. Thomas Y. Crowell Company, 432 Fifth Ave., New York 16, N. Y. 1959.

This book by a distinguished mathematician and teacher should be a source of inspiration and delight to every teacher of mathematics and physical science. Simply, clearly, and engagingly, the author presents the important role played by mathematics in the development of science. This he does principally by means of historical examples, tracing the growth of certain aspects of our knowledge from their beginnings to the present. Of necessity he restricts his study to the world of astronomy and physics, and one has the sense, as one reads, of reliving the first college physics course, but experiencing it with new insight under the guidance of a master teacher.

In an excellent early chapter on discovery and proof are discussed the inductive nature of science and the deductive character of mathematical proof. Correcting a common misconception, Kline points out that although mathematical proof is deductive, discovery in mathematics is often inductive and finds its inspiration in the solving of problems raised in the physical world.

Then follow such topics as irrational and negative numbers; the story of Ptolemy, Copernicus, Kepler, and Galileo; the scientific revolution of the Renaissance; the use of conic sections in the study of motion; Newton's work on gravitation; the development of lenses; the mathematics of oscillatory motion; magnets and charges; calculus; and non-Euclidian geometry. All this, and more, is treated with the aid of but elementary mathematics, and only occasional use is made of calculus.

The book will be invaluable in helping the teacher add to his store of background and enrichment materials. It contains many biographical details which illustrate the humanistic aspects of science. It is studded with anecdotes, some highly amusing and all of them pertinent, to help enliven a science class. It supplies illustrations, apt and authentic, for the mathematics teacher who wishes to increase student interest by showing how mathematics has uses in science and engineering. Moreover, the historical references can be trusted.

ROBERT T. LAGEMANN
Vanderbilt University
Nashville 5, Tennessee

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee
Dr. Robert A. Bullington, Chairman
Northern Illinois University, DeKalb

BOOK BRIEFS

A Short History of Science (A Symposium). Herbert Butterfield, et al. 138p. 95¢. Doubleday & Company, Inc., 575 Madison Ave., New York 22, N. Y. 1959.

Explains in everyday language the origins and results of the Scientific Revolution. Not comprehensive, the chapters survey men's ideas about the universe before the Scientific Revolution, after Newton, after Darwin, and today, consider the interaction of scientific ideas with other ideas commonly held at the time, discuss science in the light of social and economic conditions, and show why particular problems attracted attention when they did and how they were solved. Originally a series of Broadcast Talks to Sixth Forms by fifteen eminent living British scientists, philosophers, and historians, the book is suitable for a variety of students.

Atomic Radiation in the High School Science Class. Joe W. Tyson. 87p. $1.65. Oldfriend Books, 4923 Strass Drive, Austin 3, Texas. 1959.

A laudable attempt to present a variety of radiation experiments for the high school science class. Many procedures hardly seem adaptable to the average classroom because of expense, space, and time. Some, like Experiment IV, Radiographic Studies, are within reason. There is a helpful glossary at the beginning of the book, but it would take a class of above-average students to use this book as a complete unit. It can be used more successfully by the enthusiastic teacher for guiding top students in projects. Any teacher using this book should have a well-rounded background in biology, chemistry, and physics.

Working with Animals. 65p. **Working with Plants.** 58p. J. Myron Atkin and R. Will Burnett. $1 each. Rinehart and Company, Inc., 232 Madison Ave., New York 16, N. Y. 1959.

Very helpful source booklets for elementary school teachers. Emphasis on activities, although survey of plant and animal world is given. Contain tips on use of animals and plants in classroom. Include other references for both teachers and children.

Your Child in a Scientific World. Albertina A. Weinlander. 192p. $2.95. Doubleday & Company, Inc., 575 Madison Ave., New York 22, N. Y. 1959.

A revealing book for parents on introducing children to the world of science in the home. Discusses "how-to" suggestions for home activities—basement laboratory, experiments, family field trips, and guidance in the science field. Contains a graded bibliography of science materials including cost and sources. Well written, suitable for parents interested in building science attitudes for their children.

Fearon Science Education Series. Matthew F. Vessel and Herbert H. Wong. 14p each. 75¢. Fearon Publishers, 2263 Union St., San Francisco, Calif. 1959.

Upper elementary and junior high school level. Consists of five separate booklets designed as teaching guides in the areas of space, prehistoric life, water, and Alaska. Provide specific suggestions such as bulletin board ideas, correlative table exhibits, illustrated activities, and suggested correlations. The booklets are well illustrated and contain many practical experiments.

Marie Curie. Robin McKown. 128p. $2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

An excellent portrayal of the life of Marie Curie. Goes far in creating the problems and sacrifice often present in the life of a research scientist. Tells of her early education, family life, and discoveries of radioactive elements and their isolation. Also gives interesting commentary on other great scientists of the time as related to her work. Excellent reading for junior and senior high school students. Illustrated with sketches.

The Macmillan Science/Life Series—Books 1-6. J. Darrell Barnard, Celia Stendler, and Benjamin Spock. Book 1, 122p., $2.32; Book 2, 154p., $2.48; Book 3, 250p., $2.72; Book 4, 270p., $2.80; Book 5, 318p., $2.88; Book 6, 318p., $2.96. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y. 1959.

This teacher's annotated edition of a science/life series dealing with science, health, and safety is one of the finest that has been published. Each teacher's edition is prefaced by a lengthy special section of teaching suggestions. Each topic and each page of the text has comments written in red lettering to call attention to new words or new ideas. Suggestions are made as to how the teacher can best present the subject to a class. Points to emphasize are indicated. New teachers, or teachers who feel inadequately prepared in science, can gain needed confidence from such a series.

Soap Bubbles and the Forces Which Mold Them. C. V. Boys. 156p. 95¢. Doubleday Anchor Books. Order from Wesleyan University Press, Inc., Columbus 16, Ohio. 1959.

Consists of a series of three lectures given by Sir Charles Boys, covering various aspects of the soap bubble—surface tension, surface strength, shapes, and kinds. Contains many interesting experiments which can be demonstrated to classes, with section on instructions. Illustrated with sketch diagrams. Suitable for junior and senior high science. Paper bound.

Your Science Fair. Arden F. Welte, James Dimond, Alfred Friedl. 103p. $2.75. Burgess Publishing Company, 426 South Sixth St., Minneapolis 15, Minn. 1959.

Subtitled *A Guidebook to Successful Science Fairs,* this publication should be quite useful to the teacher who directs projects and enters them in science fairs. The "why," "what," and "how" of fairs are explained. Includes an annotated list of projects with some photo-

NSTA Teaching Materials Review Committee

NSTA and Northern Illinois University will continue the joint project which will cover reviews and reports of teaching materials used in elementary and secondary school science programs. The materials will include books, films and filmstrips, tape recordings, charts, laboratory apparatus, selected reading references, and related items. After review, the materials will be retained in appropriate depositories of the Northern Illinois University for use by students, faculty, or visiting educational groups. Dr. Robert A. Bullington, Department of Biological Sciences, Northern Illinois University, DeKalb, Illinois, will direct the project as chairman and be assisted by committee members: Loren T. Caldwell, Allen D. Weaver, NIU; Walter E. Hauswald, Sycamore High School, Illinois; and Robert L. Smith of DeKalb High School.

NSTA will refer related inquiries to the Review Committee, and readers are encouraged to send correspondence or materials, as described above, directly to the chairman of the committee. Suppliers and publishers of science teaching materials are requested also to send items for review and examination to Robert A. Bullington at DeKalb, Illinois.

graphs and four complete reports of outstanding projects by the students who completed them. Paper cover.

Teaching with Radioisotopes. Edited by Harold A. Miner, Robert W. Shackleton, and Fletcher G. Watson for United States Atomic Energy Commission. Order from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Introductory material in this publication is aimed at making it usable to the high school biology teacher who lacks sufficient background in chemistry and physics. It would be difficult for all members of an average class to use the various projects described for a unit study. Superior students will find excellent ideas for projects. The reviewer recommends its use.

The Vertebrate Story. Alfred S. Romer. 437p. $7. University of Chicago Press, 5730 Ellis Ave., Chicago 37, Ill. 1959.

A thorough revision of Romer's previous work, *Man and the Vertebrates.* Profusely illustrated with line drawings, photographs, and a few maps, it is highly commended. From an evolutionary point of view, Romer discusses the five classes of vertebrates and compares them showing their relationships. A discussion of Man and his position in evolution is to be found in the closing chapters. Highly recommended as a reference or as a textbook for vertebrate zoology and comparative anatomy. Presented in easily readable print and understandable English.

The Scientific Revolution, Challenge and Promise. Gerald W. Elbers and Paul Duncan, Editors. 280p. $6. Public Affairs Press, 419 New Jersey Ave., S.E., Washington 3, D. C. 1959.

This book, in reality a collection of thirty-one essays, grew out of a conference jointly sponsored by the President's Committee on Scientists and Engineers and the William Benton Foundation, in which the essayists were leading participants. Succinct appraisals by the contributors of the current science situation are especially noteworthy. Book certainly does not encourage complacency. Science teachers will be particularly interested in Section V, "Forty Million Growing Minds"—a scientific smorgasbord offering an abundance of provocative sustenance having top nutritional value.

Algae in Water Supplies. C. Mervin Palmer. 88p. Single copy, $1; quantity of 100 copies, 75¢ each. Public Health Service Publication No. 657. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 1959.

This manual was prepared for water analysts as a guide in dealing with the recognition of the more important kinds of algae together with the interpretation, and use of such information in the control or utilization of algae present in water supplies. Includes end-of-chapter references, a key, illustrations, and other aids needed for algae identification. It will also be of value to classes in biology, botany, and general science.

PROFESSIONAL READING

"Evolution of Enzymes and the Photosynthetic Apparatus." By Melvin Calvin. *Science,* 130:1170. October 30, 1959. Applying the idea of evolution to pre-biological times helps to explain the origins of life on earth and may be applied to speculations about life systems on the moon, Mars, and Venus.

"Current Trends in Linguistics." By Joseph H. Greenberg. *Science,* 130:1165. October 30, 1959. With its own systematic type of subject matter, linguistics has a unique position among the sciences concerned with human behavior.

"The Growth of Pre-School Children's Familiarity with Measurement." By O. L. Davis, Barbara Carper, and Carolyn Crigler. *The Arithmetic Teacher,* 6:186. October 1959. A study was made to investigate the growth of familiarity with measurement in four- and five-year olds. As a result, it appears that pre-school children have begun to develop measurement concepts. These findings have implications for the elementary school programs in science and arithmetic.

"Teaching Gas Law Problems in High School Science." By M. M. Gunkle. *Science Education,* 43:168. March 1959. A study

indicates that teaching gas laws by methods not involving mathematical computations is advantageous in all IQ groupings.

"How Can the Curriculum for High School Biological Science Teachers Be Improved?" By R. Maurice Myers and H. William Croll. *Science Education,* 43:147. March 1959. A questionnaire-type study indicated that more than one-third of the teacher training institutions sampled did not require either chemistry or physics for persons being certified to teach biology. Over two-thirds did not require any mathematics. As a result, it was recommended that these and other requirements be raised to provide broader preparation in science for biology teachers.

"New Books for the High School Science Shelf, Second Series: 1956-1958." By Louis Panush, Mackenzie High School, Detroit, Mich. Annotated listing of trade books compiled to help the science teacher in his recommendations for library purchases. This diversified list contains books in almost every area of science which meet the needs and interests of the mature student as well as the general, average, and below average reader. A limited number of copies are available from the author.

"Evaluation: A Memorandum for Curriculum Workers." Bureau of Curriculum Research, Board of Education, 110 Livingston St., Brooklyn 1, N. Y. April 1959. Latest of a series of curriculum research reports on objective evaluation activities for teachers and committees. The report defines evaluation, lists areas in education where evaluation could take place, discusses testing, describes the development of data, and lists standard statistical ways of organizing scores. Single copies are available for 25¢ from the Publication Sales Office, Board of Education.

"Lecture Demonstrations on Electrification by Contact." By Oleg Jefimenko. *American Journal of Physics,* 27:604-5. November 1959. Four demonstrations are described which can be used to show that only close contact between bodies, not friction, is required to give an object an electrical charge. The equipment needed to carry out the demonstration is also given.

"Graduate Examinations in Physics." By M. W. Strandberg and B. V. Gokhale. *American Journal of Physics,* 27:539-44. November 1959. The type and number of graduate level examinations for doctoral candidates in physics are discussed with respect to the objectives which the examination program serves. A review of examination procedures in graduate physics throughout the United States is also included.

"Do We Need a National Curriculum?" By Ralph W. Tyler. *The Clearing House,* 34:141. November 1959. Report of the Conference on policies and strategy for strengthening the curriculum of the American public schools. The conference recommends the establishment of study groups in each subject (as there have been in physics and several other areas) and that another group study the organization of the curriculum as a whole.

"Symposium on Recent Research in Science Education." By George G. Mallinson. *School Science and Mathematics,* 59:624. November 1959. Research findings at each of the three levels of science instruction, ele-

mentary, secondary, and college are summarized briefly. In addition, the implications of the findings at each level are pointed out.

"The Growth of Nerve Circuits." By R. W. Sperry. *Scientific American*, 201:68. Studies of nerve repair in frogs and rats indicate that organization of certain nerve centers takes place in the early stages of growth. Implication is made that injury to animals cannot be repaired by re-education. A biological basis for reflexes and other patterns of inherited behavior may thus be provided.

AUDIO-VISUAL AIDS

Time. The basic concepts of time and time measurement are simply explained by line drawings, models, animation, and live photography. Standard time zones, daylight-saving time, Greenwich time, and the International Date Line are covered. The sun is used to show how nature has determined all our concepts about time. Animated drawings of a high-speed rocket traveling from time zone to time zone and then across the International Date Line make graphic the world picture of time and date differences. For grades 5-9. 15 min. Color $150, B&W $75. 1959. Audio-Visual Center, Indiana University, Bloomington, Ind.

Seed Plants. Six filmstrips for upper elementary and junior high grades. Give suitable concepts for class discussion. Excellent photography and accurate captions illustrate these concepts in a logical, progressive development. Offer possibility of stimulating duplication of basic plant study experiments. Filmstrips: *Green Plants*, 26 frames; *Seeds*, 26 frames; *Roots*, 25 frames; *Stems*, 25 frames; *Leaves*, 25 frames; *Flowers and Fruits*, 25 frames. Color. Set $30; $5 each. 1958. Produced by Creative Education, Inc. Distributed by International Film Bureau, Inc., 57 East Jackson Blvd., Chicago 4, Ill.

Boats: Buoyancy, Stability, and Propulsion. Illustrates the basic principles which give boats buoyancy and stability and which make it possible to propel them through the water. Archimedes' principle is illustrated in a laboratory set-up. Useful in any course dealing with gravity, mechanics of liquids, and machines. Recommended for junior high grades. 13 min. Color $137.50, B&W $75. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.

Water for the Community. Traces water from its source to its many uses by man. Graphically illustrates steps and problems involved in treatment and distribution. Emphasizes problems common to all communities. Machinery, equipment, and cut-away models used effectively. Excellent for junior high. 11 min. Color $110, B&W $60. 1958. Coronet Films, Coronet Bldg., Chicago 1, Ill.

Watershed Wildfire. A documentary film on an 85,000-acre fire near Santa Barbara, California. Shows, with superb photo sequences and narration, how dangerous, destructive, and costly a wild fire can be. Describes problems of protecting a watershed from erosion after a fire and shows methods used. A prize-winning film, excellent for high school, college, or adult groups. 22 min. Color, free. 1959. U. S. Dept. of Agriculture, Office of Information, Motion Pictures Service, Washington 25, D. C.

Tide Pool Marine Life. A set of 12 full-color, captioned prints, 11 x 14 inches. Included are pictures of tide pool shorelines and many of the animals that inhabit the area. Reverse side contains descriptive text. Excellent photography. A unique aid for elementary and secondary biology. $8.95 per set; cheaper in quantity. 1959. Filmscope, Inc., Box 397, Sierra Madre, Calif.

Reptiles and Their Characteristics. A well-organized, interesting and accurate film about snakes, lizards, turtles, and crocodilians. Covers general characteristics and habits of representative species. Photography and narration of high quality. Designed for intermediate grades but quite useful at higher levels. 11 min. Color $110, B&W $60. 1959. Coronet Films, Coronet Building, Chicago 1, Ill.

Circulation—Why and How. For biology and health classes in junior and senior high. By excellent animation, the path of the

blood is traced to and through the heart and out through the pulmonary and systemic circulations. Movement of food, oxygen, and wastes covered. The film does not replace others showing scenes from living animals, but it is a valuable supplement that will make circulation quite understandable. 10 min. Color $110, B&W $60. 1959. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Spring Comes. Designed to help children in the primary grades to learn about the changes in spring, to stimulate their observation, and to create an appreciation for the adjustments of plants and animals in the spring. Five filmstrips: *Birds in Spring*, 22 frames; *Animals in Spring*, 21 frames; *Insects in Spring*, 22 frames; *Plants in Spring*, 22 frames; *People in Spring*, 20 frames. Color $23 per set. 1958. The Jam Handy Organization, 2821 East Grand Blvd., Detroit 11, Mich.

The Size of Things. An interesting animated presentation of the relationships that exist when the size of living creatures is either increased or decreased. What would happen to relative strength if a beetle or a mouse were increased to the size of a boy, or if a boy were decreased to the size of a beetle? Concepts clearly understandable for upper elementary grades. May also be used in secondary science. 10 min. Color $110, B&W $60. 1959. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

Exploring by Satellite. An educational film dealing descriptively with the physical properties of satellites, space, and man's control over their use. The film is visually adjusted to junior high students, with senior high scientific terminology. It raises some basic-law questions about the earth, space, and motion now studied on a college level. Presentation of information and ideas has been very well organized, clearly presented, and thoroughly authenticated. The film has no counterpart available to schools at this date. Useful for all levels from junior high to adult. 28 min. Color $240, B&W $120. 1959. Delta Film Productions, Inc., 1821 University Ave., St. Paul 4, Minn.

APPARATUS & EQUIPMENT

Low Friction Air Puck. A five-inch plastic base and a special balloon provide a fascinating model which will float on a flat surface on a cushion of air. Operates on the same principle as the new wheel-less air-glide cars. When slightly touched it will slide frictionlessly across a table. Excellent demonstration model in the study of friction. Extra balloon included. $2. Edmund Scientific Company, 101 East Gloucester Pike, Barrington, N. J. 1959.

Brainiac: Computer Circuits Kit. A kit of six discs, light sockets, wire, and other parts and tools needed for assembly of this demonstration computer. Operates on flashlight batteries. Mounts on a box frame and may be used to demonstrate computation of mathematical processes, science concepts, and problems of logic. An interesting piece of equipment, suitable for demonstration and experimentation in junior and senior high schools. Includes directions for assembly and suggested experiments. May be reassembled many times to solve different problems. $18.95. Science Materials Center, Inc., 59 Fourth Ave., New York 3, N. Y. 1959.

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